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ABSTRACT

Four papers report on phonetic differences between Finnish and English, with pedagogical implications for teaching English as a second language. "The English /ptk/-/bdg/ Distinction: Data and Discussion" by Kari Suomi is a survey of recent work on the phonetic parameters of the fortis/lenis distinction. The distinction "voiced-voiceless" is preferred to "fortis-lenis." In "The Voiceless-Voiced Opposition of English Consonants: Difficulties of Pronunciation and Perception in Communication between Native and Finnish Speakers," Risto Hanninen analyzes the learning difficulties encountered by Finns in isolated words, in words included in word lists, and in words embedded in meaningful sentences. Learning difficulties vary greatly according to context. In voiced-voiceless identification tests, Finnish students failed to identify most of the tested oppositions. In "Vowel Reduction in the English of Finnish Learners" by Hannele Heikkinen, the quality of the final reduced vowel in English, when used by Finnish speakers, was found to be influenced by lip rounding reflective of Finnish "oe." Finally, in "The Discrimination and Identification of English Vowels, Consonants, Junctures and Sentence Stress by Finnish Comprehensive School Pupils," Reijo Lamminmaki deals with problems of language testing as related to identification problems, and questions the usefulness of existing tests in interlanguage research. (JB)

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# PAPERS
# IN CONTRASTIVE PHONETICS

edited by

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PREFACE

The Finnish-English Contrastive Project was started at the University of Jyväskylä in the spring of 1974. The project has been carried out in two parts: the Department of Phonetics and General Linguistics is responsible for the work on pronunciation problems, and the Department of English is concerned with other aspects of the research. Several reports have been published previously on phonetically orientated topics (eg. Moisio and Valento 1976; Suomi 1976; Lehtonen and Koponen 1977; Sajavaara and Lehtonen 1978a; Lehtonen 1978) and the results have also been applied to language teaching purposes in a textbook of spoken English (Lehtonen, Sajavaara and May 1977). The methodology and problems of contrastive phonetics have been discussed by eg. Lehtonen (1977; 1979). In co-operation with the Error Analysis Project at Abo Akademi, the Contrastive Project has also carried out some tests; the results have been summarized in Palmberg (1979). In addition, the problems concerning the influence of English language and culture on present-day Finnish have been studied in co-operation with the Anglicism Project at the University of Jyväskylä (see eg. Sajavaara et al. 1978).

In traditional contrastive analysis – an analysis of the similarities and differences of two sound systems – it was supposed that the difficulties of foreign language students could be described and predicted. The 'strong hypothesis' of contrastive analysis has been much criticized (see eg. Sajavaara 1977). It obviously failed to recognize the importance of actual problems in learning situations which is exactly the kind of knowledge that the FL teacher needs in his classroom practice. Moreover, the focus was on foreign language production: the role of the listener, which is equally important, was grossly underestimated. The listener's impressions of speech derive from internalized categories of rules and structures usually called phonology. Thus, he does not hear the actual physical utterance but a chain of segments corresponding to the expectations about the utterance. This is typical of human perceptual mechanisms in general: we observe structures of whose existence we have discovered and which we choose to observe. For a speaker-hearer, language is an earphone through which he can hear only language, not speech. Thus, many of the acoustic cues which actually carry the information necessary

for speech perception are subconscious (eg., formant patterns of vowels, consonantal loci and transitions, temporal patterns of utterance, etc.). Although a speaker can pay conscious attention to certain postures and movements of his speech organs, both the way in which they actually operate during speech and the resulting acoustic message are beyond the scope of conscious observation.

All this has important consequences: the contrastive analyst and the foreign language teacher must realize that the way in which they 'hear' a certain pattern may be totally different to the way in which the student perceives the same thing. The problems of the foreign language student can be understood only if we know how he 'feels', what he attempts to hear, what he actually hears, what the structures are that he actually perceives, and how these differ from the target, ie. the way the native speaker's perception works in similar situations.

Therefore, the focus of studies should not be on 'pronunciation' only but on a complex of problems which extend far beyond the area of what is traditionally called pronunciation teaching. This complex includes the differences in the learner's L1 and L2 communication chains as a whole, as well as the problems and confusions arising from the fact that the learner unconsciously resorts to L1 phenomena not only when producing L2 but also when trying to understand L2.

The majority of the contrastive phonetic studies carried out within the Project were, however, limited to specific phonetic phenomena: the fortis/lenis distinction, vowel reduction, word and sentence stress, consonant clusters, word boundaries, fluency, pauses, the acceptability of the Finnish variety of pronunciation, the reliability of the marking of pronunciation errors etc. (for closer discussion, see eg. Sajavaara and Lehtonen 1978b). The present volume is a final report on the strictly phonetic part of the project. Some of the topics included in the original research programme cannot be reported here, either because they have been delayed or the methods applied have proved to be inadequate and the results are therefore unreliable. That is why studies on such important topics as word and sentence stress or rhythm and intonation are not found in this volume. In addition, some of the later studies have a wider scope: they deal with various aspects of discourse and not with specific pronunciation problems. The reports of these studies, which also include non-verbal communication analysis, are not included here, since a separate issue

dedicated to discourse analysis will be published in this series.

Two of the present papers are concerned with the fortis/lenis distinction. The paper by Suomi is a version of a paper read at the 8th Meeting of Finnish Phoneticians at Jyväskylä in 1978. It is a survey of the recent work on the phonetic parameters of the fortis/lenis distinction and a discussion of the theoretical problems involved. In his discussion of the problems of labelling the distinction the author prefers the terms "voiced-voiceless" to "fortis-lenis", which were recommended for pedagogical purposes by eg. Lehtonen (1971) and Gimson (1962). In a related study, Hänninen has analysed the learning difficulties encountered by Finns in three different contextual environments: in isolated words, in words included in word lists and in words embedded in meaningful sentences. The durational pattern of words embedded in meaningful sentences appeared to be clearly different from the other environment. Acoustical data on the fricatives and affricates also turned out to be different from that of the plosives. The learning difficulties of Finns vary a great deal according to the context. In identification tests, Finnish students failed to identify most of the tested oppositions. English listeners had considerable difficulty in identifying the opposition as produced by Finnish speakers. Reduction of the final vowel in English VCV-structures is discussed by Heikkinen. As regards the learning problems of Finnish students, she discovered that the duration used by Finns was either influenced by the mother tongue (ie. it varied according to the quantity of the first syllable) or it was generally too short. The quality of /ə/ used by Finnish speakers was usually influenced by lip rounding, which reflects the influence of Finnish /ö/. Heikkinen also includes a short discussion of co-articulation and some tentative results concerning the co-articulation between the initial and final vowels. Lamminmäki deals with certain problems of language testing as related to identification problems. The identification cues used by Finns turned out to be dramatically different from those of native speakers. Lamminmäki also considers the adequacy of the tests available in interlanguage research. Their effectiveness in revealing the "critical" points in the interlanguage channel is rather limited.

The inadequacy of present tests of TL skills is partly due to the fact that we lack an integrated picture of the mechanisms functioning in native-language communication. Indirectly, however, foreign-language

speech perception may be approached through an analysis of the learner's production. If the features of production that are important in syntactic and semantic processing deviate from those of a native speaker, it can be predicted that the learner also has difficulties in his perception. Similarly, if native-like features are found in the production of the learner, it can be expected that he is more or less capable of using the same cues as a native speaker in his perception. However, quite unexpected elements may be confused with each other. For example, a Finn may fail to perceive or produce the fortis/lenis distinction as a result of the long/short distinction of Finnish vowels. Differences in signalling higher-level information, such as morphological and syntactic patterns, lexical units, or textual features can also result in interference in speech communication. For instance, the process of lexical word detection in English may be somewhat different from that of Finnish, due to the typological differences (isolating vs. agglutinating) between the two languages (see eg. Karlsson 1976; Lehtonen and Koponen 1977; Ringbom 1979).

The crucial question in contrastive field-work is what is it that we want to test? Do we want to test the student's knowledge of linguistic structures, or his capacity to communicate in a foreign language? The static view of language emphasizes the importance of linguistic structures as such, whereas the dynamic view of language stresses the communicative situation itself: what goes on in the mind and environment of the speaker-hearer. The phoneticians' attention has traditionally been focused on the linguistic code.[1] The assumption, however, that linguistic categories as such could be transferred to the analysis of speech communication is not legitimate. Phonemes, morphemes, or junctures, for example, are not necessarily relevant units in either speech processing or language acquisition (Sajavaara and Lehtonen 1979, Lehtonen and Hurme 1979). As a matter of fact, it is far from self-evident that these units have any connection with the processing of information in communicative tasks. It was therefore rather unfortunate that items of a structuralist phonological analysis were also regarded as basic elements in language teaching: phonetic differences, for example, were divided into phonological and allophonic ones. Phonological errors were dangerous, while allophonic ones were unimportant. Distinctive prosodic features were taught with special care, eg. English stress oppositions

[1] The narrowness of the traditional phonetic point of view has been emphasized by eg. Ladefoged (1977:410).

like 'import/im'port, or distinctive intonation patterns like Tune 1 and Tune 2, whereas non-distinctive features were given little attention in teaching materials and textbooks. In short, teaching based on structuralist view of language regarded the various levels of grammar as if they existed in isolation. In pronunciation teaching, it was not seen as necessary to pay any attention to levels other than that of phonology.

The dynamic , or communicative view of language emphasizes the communicative behaviour of the language learner. It is acknowledged that the success or failure of a communicative act does not depend solely on the linguistic structures internalized by the speaker: we have to consider various psycho- and sociolinguistic aspects in addition to all levels of grammar. One aim of future studies on contrastive phonetics will be to throw light on the speech behaviour of the foreign language student: a more proper term for such analysis may be cross-language communication analysis. After all, more interesting than knowing what linguistic structures the speaker uses in his interlanguage grammar is knowing why, how, and when he uses them.

J.L. & K.S.

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# VOWEL REDUCTION IN THE ENGLISH OF FINNISH LEARNERS

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## INTRODUCTION

The aim of the present study is to discuss some theoretical aspects of English vowel reduction and their possible implications for Finnish learners of English. The question of vowel reduction is both linguistically and phonetically complex. Its status in a grammar is vague. It is particularly difficult to draw a line between competence and performance where vowel reduction with all its phonetic parameters is concerned, as Chomsky and Halle (1968:110) note. There have been various interpretations of the grammatical status of the reduced vowels in English (see eg. Chomsky, Halle and Lukoff 1956) according to which /ə/ is the only reduced vowel in English. According to an alternative interpretation English vowels are divided into two systems: a full vowel system and a reduced vowel system. The concept of reduced vowel system was introduced by Trubetzkoy (1969). This kind of solution has been suggested by eg. Hultzén (1961), Lehiste (1970), Nyquist Goës (1974) and Wiik (1965).

In the present study the term vowel reduction is used to imply the fact that in unstressed positions the number of English vowels is reduced to two: /ə/ and /ɪ/. The study is mainly concerned with segmental factors and such factors as speech rate or rhythm are thus excluded. These factors would necessarily demand a different kind of analysis, probably requiring consideration of syntactic and semantic factors. Jakobson and Halle have noted (1968:413-414) that the sound structure of speech may be astonishingly elliptic, depending on the situation, speech rate etc. but if the necessity arises, the speaker can immediately translate his utterance into the explicit form, which the listener can readily understand. The framework of the present study is the explicit form cited by Jakobson and Halle, rather than the form used when "a variety of other factors (speed, casualness, frequency of the item, predictability etc.)" (Chomsky and Halle 1968:111) is involved. The phonetic analysis occurs thus on the level of word rather than on the level of sentence or discourse.

Phonetic discussions of vowel reduction are as various as phonological ones. Generally, shortening has been seen as one of the factors determining vowel reduction. Thus for example Lindblom (1963) argues that reduction is caused by the fact that neural commands to the articulatory mechanism follow each other too rapidly and the mechanism is not able to reach the vowel target, thus resulting in "undershoot". Lindblom thus uses the term 'vowel reduction' to cover phenomena caused by timing and speech rate. Another phonetic parameter of vowel reduction is centralization. It is usually stated in textbooks that reduced vowels are shorter, and more centralized than stressed ones. This implies that the formant values of a reduced vowel glide towards those of a neutral vowel: 500 Hz, 1500 Hz and 2500 Hz. A third parameter of vowel reduction, not usually mentioned in textbooks, is greater contextual assimilation, or coarticulation with environment. Thus for example Ohde and Sharf (1975) use the term 'vowel reduction' to imply the influence of the consonant upon the vowel. Vocalic influence and influence of the position have also been discussed in phonetic literature. These three factors will be considered in this study and term 'reduction', as a phonetic term, is used here to refer to the changes in duration and quality that characterize members of the English system of reduced vowels.

BACKGROUND OF THE STUDY

The methodological approach of this study is based on contrastive phonetics. There has been general suspicion of the results of contrastive studies (see eg. Sajavaara 1977:14), since, according to the critics, the results seem too abstract, or too trivial, for any applications to language teaching. Criticism has also been made of the static point of view expressed in contrastive studies: communicative competence and pragmatic problems have been badly neglected (for a closer discussion, see eg. Lehtonen, Sajavaara and May 1977:20-22). There is no need, however, to reject the approach because of various obvious shortcomings in its early applications. Thus, for example, the contrastive approach does seem natural in considering the phonetic difficulties of foreign language learners. The phonetic process of speech production is, after all, the only level of analysis, which offers empirical evidence for the equivalence between the sound segments in languages, as Lehtonen (1977:3[illegible]) remarks.

Foreign accent can be defined as acoustical deviations from the norm of the native speaker (Jonasson and McAllister 1972:11). The factors contributing foreign accent can thus be measured.

It has to be noted, however, that pronunciation errors are not always regular, or predictable. But some predictions can be made. Errors can be caused by the influence of the mother tongue, or they may be due to the incorrect interpretation of the rules of the foreign language. Generally, phonetic errors attributable to the influence of the mother tongue may be said to reflect a rather low level of competence in the foreign language (cf. Lehtonen 1977:32). Certain errors, however, seem to "fossilize" (cf. Selinker 1972) and remain in the pronunciation, being typical for speakers of a specific language. On the other hand, a speaker may himself construct an accent component "which has no reference in either of the languages he has been exposed to" (Jonasson and McAllister 1972:23). These incorrect pronunciation rules are typical for more advanced students, such as the informants of the present study. This accent component can, naturally, change, and the student can eliminate certain rules and form new ones. But it seems that a foreign accent cannot be totally eliminated, if the learner is an adult (cf. Lenneberg 1967:181) although it can be greatly improved. It has to be noted, too, that all errors are not equally serious from the communicative point of view, and some accents can be tolerated better than others. These, and other related problems should be given serious attention in teaching (for a closer discussion of pronunciation errors, see Sajavaara, Lehtonen and May 1977:9-22). One problem, which had to be neglected in the present study, is the role of the hearer in the communicative situation, ie. the perceptual aspects of vowel reduction. According to Lehtonen (1977:36), negative transfer in language learning is to a great extent due to different cue patterns in mother tongue and target language. This implies that the incorrect pronunciation is often only a reflection of "incorrect" hearing. Although the various acoustic cues involved in the perception of a reduced vowel have been analyzed, the relative importance of them for the hearer has not yet been tested.

THE PROCEDURE OF THE STUDY

Disyllabic English words with the structure CVCV were selected as test material. The final unstressed syllable was thus available for study. The initial consonant (C1), was, when possible, a labial, while the intervocalic consonant (C2) was alveolar. The consonants were plosives, if possible. The final vowel (V2) was /ə/ or /ɪ/. All the English vowels, and the diphthongs as well, occurred in the position of V1, the initial vowel. The principal aim was to determine the vocalic influence of the stressed vowel upon the unstressed one. The durational factors, mainly the influence of the preceding syllable upon the final vowel, were also considered.

The informants (N=15) read the test words (N=45) embedded in a sentence frame and their productions were recorded on tape in the Phonetics Laboratory at the University of Jyväskylä. The tape recorder was Revox A77 and the microphone AKG D-202. The informants were grouped according to their level of competence in English. There were 5 native speakers of English (E), 5 students of English who had acquired a *cum laude* -level in their English studies (S1), and 5 students of other subjects (S2). The language skills of the S1 group can be assumed to be typical of English language teachers in Finland, whereas the S2 group represents fairly well the language skills that are received in secondary school. All informants were male because of the spectrographic analysis.

Spectrograms were made from all test words using the Kay Elemetrics Sona-Graph 6061B of the Phonetics Laboratory. The nominal bandwidth was 150 Hz, resulting in a practical bandwidth of 300 Hz when the double recording speed was used. The upper limit of the frequency scale was 4000 Hz. The duration of V1, V2, and C2 was measured from the spectrograms with a 5 msec accuracy. The duration was determined according to the beginning and the end of the second formant. The formant frequencies of the first three formants were measured for both V1 and V2 with an accuracy of 50 Hz (see Appendix).

The statistical analysis required was carried out at the Computer Centre of the University of Jyväskylä. A t-test was used to indicate the differences in means between the informant groups. The results include means ($\bar{X}$) of various phonetic parameters, their standard deviation (SD); and the statistical significance of the differences in means between three informant groups. Significance is indicated as follows: + =almost sign., p 5% ; ++ =significant, p 2% ; +++ =very sign., p 1% ; and ++++ =strongly

sign., p 0.5%; *non* = no statistical significance. (The differences of means have been compared for the most part between informant groups, but occasionally also between word groups etc.). Some additional calculations were made using the Compucorp calculator of the Phonetics Department.

PHONOLOGICAL ASPECTS OF VOWEL REDUCTION

It is a fairly common tendency among the world's languages that there are fewer vowels in unstressed positions. According to Trubetzkoy (1969: 236) this phenomenon is called reductive neutralization (a subprocess to vowel neutralization; cf. Donegan Miller 1972), and it means that the phonological oppositions are neutralized in unprominent positions.

Reductive neutralization is a process common to several languages, but the specific rules vary - as Trubetzkoy states (1969:228) - from language to language, and from dialect to dialect. To name but a few examples: in Swedish (Sigurd 1965:142), the number of vowels is reduced to two in certain positions; in Italian (Tagliavini & Mioni 1975:64) the oppositions /e/ - /ɛ/ and /o/ - /ɔ/ are neutralized in unstressed position; in Modern Greek (Haiman 1972:368) the process is similar to that of Italian; and in Russian (Trubetzkoy 1969:236) only three vowels are capable of occurring in unstressed position. It can also be suggested that there is a reduced vowel system in English consisting of the vowels /ə/ and /ɪ/. [1] /ʊ/ has also been proposed as part of the system, but it seems to be generally agreed that it is rather marginal (Gimson 1966:142; Wiik 1965:135). There is also a certain amount of free variation between /ə/ and /ɪ/, but the opposition is always present word-finally as in *city* - *sitter* (Wiik 1965:135).

In Estonian, too, there is a subset of four vowels that occurs only in unstressed positions (Lehiste 1970:141); but there do not seem to be such restrictions in Finnish. It can be suggested, however, that the Finnish vowel harmony rule serves a similar purpose, since it restricts the possible choice of unstressed vowel. Trubetzkoy (1969:236) classified vowel harmony as a case of reductive neutralization, as vowel harmony

[1] Sometimes a full vowel quality occurs in unstressed position. This can be attributed to the presence of secondary stress (see eg. Gimson 1966: 141-143).

means that certain vowel oppositions are fully relevant in word-initial syllables only. In Finnish every vowel is capable of occurring in unstressed position. Nevertheless, the distribution of vowels is limited by vowel harmony. The initial vowel of the word, which also always carries the primary stress, determines the quality of the following vowel according to the word-internal vowel harmony principle. The appearance of a back vowel /a o u/ in an initial syllable presupposes a back vowel in the following syllable, and a front vowel /ä ö y/ presupposes a front vowel. The phonetically front vowels /i/ and /e/ are neutral to vowel harmony, and can occur with either front or back vowels. [1] To show the common function of vowel reduction and vowel harmony, Trubetzkoy suggested a concept of 'prominence' that would phonologically manifest itself by stress or length, and morphologically (as in Finnish) by a 'weight' on the initial syllable.

Accordingly, there is a general tendency to strengthen prominent syllables, or to make them perceptually as distinct as possible. This manifests itself in morphological, phonological and phonetic features, such as lengthening, diphthongization, stress etc. (cf. Schane 1973:58; Hyman 1975:208). A complementary tendency is towards weakening of the unprominent syllables, which manifests itself in various ways, too: reduction, elision, etc. The differentiation of these two kinds of syllables is of course a perceptual aid for the listener. The actual process is different in different languages. In English, the reduced number of vowels is used to create a greater perceptual distance between them. The listener can "concentrate" more on the stressed syllables, when he knows he has to distinguish only between two vowels in unstressed positions. In Finnish, the listener can make predictions about the quality of the final vowel only after he has heard the initial syllable. The process creates a closer perceptual unity within the word, and it is one of the factors that creates word-internal cohesion typical of a synthetic language like Finnish (for a discussion of word-internal cohesion, see Karlsson 1977).

[1] The above discussion on Finnish vowel harmony is by no means complete. Vowel harmony has been discussed in detail by eg. Wiik 1975 and Karlsson 1971.

## PHONETIC ASPECTS OF VOWEL REDUCTION

### DURATION

It has been often claimed that duration is the primary factor of vowel reduction (cf. Lindblom 1963). In English, as well as in various other languages, stress and duration seem to be positively correlated. The actual phonetic manifestations of stress are various. Lieberman (1970:314) mentions changes in fundamental frequency, sound pressure level, duration and coarticulation. A stressed syllable has greater duration, higher fundamental frequency and lower degree of coarticulation. [1]

In English, it is argued, a stressed syllable is habitually longer in duration. This seems to have been established by several studies (eg. Parmenter & Trevino 1935; House 1961; Klatt 1975). Usually, the duration of secondary stressed vowels is slightly shorter than that of the primary stressed ones (Wiik 1965:134; Klatt 1975:31). The positive correlation between stress and duration has been reported to exist in several languages: in Swedish (Hadding-Koch 1961), in Polish (Jassem 1959), in Russian (Jones & Ward 1969:206) etc. However, the rule that lengthens stressed vowels is not strictly speaking universal. There are languages in which the increase of duration in stressed syllables is minimal, or non-existent, and stress manifests itself in other ways. According to Lehiste (1970:36) these languages include Czech, Estonian and Finnish. It is obvious that duration in these languages is used primarily as a cue for linguistic quantity. Unstressed syllables can also be longer than the stressed ones (they are regularly longer in Estonian, as Lehiste 1970:138 notes).

What is the relative importance of duration as a cue for stress and thus as a cue for reduction? It has been claimed that duration universally is the primary cue for stress (cf. Thelin 1971:145). The tests of Fry (1965) and Lieberman (1967:30) show that English listeners do rely heavily on duration when judging whether the syllable is stressed or not. According to Bolinger (1958:111) the primary cue for stress

[1] For a closer examination of parameters of stress, see eg. Lehiste 1970.

is provided by pitch. It can be argued (cf. Ladefoged 1967:46) that there is no single acoustic event that is characteristic of all stressed syllables in English. It seems probable that different cues are in close interaction, and that their importance depends on the prevailing situation.

According to Lindblom (1963:1780) timing is the primary variable in vowel reduction, and articulatory imprecision or laxness is the consequence of the shortened duration, and can thus be neglected in considering the causes of reduction. Naturally vowels lose their original colour when they become very short. According to Delattre (1969:298) there is a different "duration-to-obscuration ratio" for each vowel. This means that when the duration of a vowel segment is decreased, there are less and less correct identifications. The loss of /a/ -colour should occur at c. 1.5 msecs but the loss of /i/ -colour not until c. 1.25 msecs.

The above view of vowel reduction has been criticized by eg. Lehiste (1970:140) and Nyquist Goës (1974:70). They base their criticism on the fact that there are reduced vowel systems in many languages. If reduction is seen as a systematical phenomenon, it has to be acknowledged that the vowel quality parameter cannot be ignored. Also, unstressed vowels can be longer in duration than stressed vowels, and still no de-reduction occurs. It seems, though, that the term 'reduction' is again used with slightly different meanings. Lindblom's data consists of Swedish CVC syllables, and vowel reduction is what occurs to the vowel when the speech rate is increased. Lehiste sees reduction as a phenomenon of language system: variation of two vowel systems. While Lindblom's results are undoubtedly correct, it cannot be claimed that duration is the only factor that causes reduction, if reduction is regarded in a wider linguistic sense.

As regards Finnish, it can be said that duration cannot be a decisive cue for stress. Stress is fixed in Finnish: main stress falls always on the initial syllable and every other syllable receives a secondary stress. The last syllable is unstressed. Stress is thus predictable and serves as a boundary signal. The phonetic parameters of Finnish stress have not been studied much. Raimo (1972)[1] showed with a synthetic stimulus listening test that increase in intensity does not increase the identifications of

[1] A paper read at the Second Conference of Phonetics, Jyväskylä, Finland, 8.-9.1.1972.

stress, while a change in pitch seems to influence the impression of stress. Wiik (1976)[1] suggested in a study of word boundaries that intensity, fundamental frequency, duration, and quality can all act as cues for stress in Finnish. Sovijärvi (1954) connects stress to rhythm, and argues that rhythm, and thus also stress, is manifested mainly through variations of intensity. Lehtonen and Koponen (1977:75) include also glottalization as a manifestation of (sentence) stress. No systematic survey of the parameters of Finnish stress has been made, and it seems realistic to presume that their relative importance depends on the contextual factors, as in English.

Duration cannot be a primary cue for stress, since it is used mainly to signal linguistic quantity. Phonologically single and double vowels and consonants are distinguished mainly by their different duration (eg. *tuli* "fire" vs. *tuuli* "wind"; *tuli* "fire" vs. *tulli* "Customs"). The doubling of a segment is not a sign of prominence in Finnish: both single and double vowels can occur in stressed as well as in unstressed positions (eg. *tulee* "he comes", where the final vowel is unstressed [e:]). Finns do seem to use the duration cue primarily for distinguishing single and double vowels, even if there is also a difference in their quality (Lehtonen 1970:86-88). The difference in quality between shorter and longer vowels seems to be a kind of phonetic universal. English uses this feature to distinguish between /tense/ and /lax/ vowels, while Finnish does not use it to distinguish between /single/ and /double/ vowels. Finnish uses duration for distinguishing vowels, while English uses it mainly to signal stress.

In Finnish the question of duration is, however, more complicated. As it was stated, both single and double vowels can occur in the final syllable. The actual physical duration of the final vowel is, however, influenced by the preceding syllable, especially when the intervening consonant is single Thus both single and double vowels are shortened, if the preceding syllable is long (ie. having a double vowel, a diphthong or a vowel - consonant combination). Accordingly, the final vowel is usually slightly longer in *tulee* "he comes" than in *tuulee* "the wind blows", and considerably longer in *tuli* "fire" than in *tuuli* " the wind".

[1] A paper read at the Sixth Conference of Phonetics, Joensuu, Finland, 24.-25.6.1976.

There are also four actual durations for the unstressed final syllable of a disyllabic word. In English the duration does not depend on the preceding syllable. This must cause certain problems for Finnish students; they will probably overdifferentiate the English durations. Wiik (1965:138) has noted, that students tend to use these different variants, short and half-long, depending on the preceding syllable. The half-long variant is used in words like *bitter* and the short in eg. *beater*. Wiik suggests that students should get rid of the half-long variant. The results gained in the present study seem to indicate, however, that the half-long variant would in fact be the more correct one. The results concerning duration are summarized in Tables 1 and 2.

Table 1. The average durations (msecs) in certain word groups

| | | $V_1$ $\bar{X}$ | $V_1$ SD | C $\bar{X}$ | C SD | $V_2$ $\bar{X}$ | $V_2$ SD |
|---|---|---|---|---|---|---|---|
| V1 = tense | E | 168 | 53 | 103 | 30 | 71 | 32 |
| | S1 | 171 | 50 | 89 | 33 | 71 | 39 |
| | S2 | 153 | 35 | 100 | 33 | 74 | 36 |
| V2 = /ə/ | E - S1 | non | | non | | non | |
| | E - S2 | non | | non | | non | |
| | S1 - S2 | non | | non | | non | |
| V1 = lax | E | 82 | 24 | 131 | 20 | 80 | 25 |
| | S1 | 76 | 18 | 121 | 25 | 84 | 39 |
| | S2 | 83 | 16 | 118 | 26 | 84 | 32 |
| V2 = /ə/ | E - S1 | non | | non | | non | |
| | E - S2 | non | | non | | non | |
| | S1 - S2 | non | | non | | non | |
| V1 = diphthong | E | 173 | 38 | 97 | 41 | 72 | 26 |
| | S1 | 173 | 40 | 82 | 35 | 75 | 40 |
| | S2 | 179 | 39 | 79 | 45 | 80 | 34 |
| V2 = /ə/ | E - S1 | non | | non | | non | |
| | E - S2 | non | | non | | non | |
| | S1 - S2 | non | | non | | non | |

The table shows the average durations of all vowels in each informant group, the standard deviations (SD) and also the significance of the differences of means (+ = almost significant, $p<5\%$; ++ = significant, $p<2\%$; +++ = very significant, $p<1\%$; ++++ = strongly significant, $p<0.5\%$).

When the final vowel is /ə/, (Table 1) there does noet seem to be any great difference between the performances of English and Finnish speakers. Finnish speakers do produce a shorter variant, if the preceding vowel is tense - since Finns interpret the tense vowel as a double vowel and thus the syllable as a long one - but so also do native English speakers. Finnish speakers do not seem to be affected by the rules of their mother tongue. There are various explanations for this seeming lack of error. One is the fact that Finnish listeners can in fact hear the final vowel as a lengthened one. In a listening test carried out by Wiik (1965: 138) 15% of the listeners (schoolchildren) designated the final vowel with two vowel letters. This happened more often after a tense vowel. This shows that a Finn may hear that English speakers use a longer variant than he is accustomed to hearing in the respective position in his own mother tongue. More probably the students were affected by the letter r that occurred in the orthographic representation of the test words. Many students were obviously unsure, whether to pronounce the /r/ or not. They may also have been influenced by American English pronunciation. However, the hesitation, or the production of some kind of [r] may obscure the results with this group of words. Yet another factor that can influence the results is the statistical method used. In a small sample like this the opposing tendencies may create a misleading image. Thus it seemed that some of the students regularly commit the expected errors, while others do quite the opposite. As only the means of each informant group were compared, individual tendencies may have been ignored. Yet it can not be claimed that the students had achieved an error-free pronunciation. This can be seen more clearly in the results that concern words ending with /ɪ/, which have been presented in Table 2.

As it can be seen in Table 2, Finnish students produce regularly a significantly (++++/+) shorter vowel than the English speakers, if the preceding vowel is tense. This is just what was expected. The unexpected thing is that the error seems to be committed systematically by the students of English, not by the other students. Again, the error is seen only as regards the position where the initial vowel is tense. This is explained by the fact that the duration used after a lax vowel matches the "correct" English duration. It seems, too, that the duration used by Finns for final

Table 2. The average durations (msecs) of certain word groups

| | | $\bar{X}$ $V_1$ | SD | $\bar{X}$ C | SD | $\bar{X}$ $V_2$ | SD |
|---|---|---|---|---|---|---|---|
| V1 = tense | E | 184 | 36 | 89 | 34 | 88 | 26 |
| | S1 | 183 | 44 | 69 | 24 | 60 | 29 |
| | S2 | 184 | 40 | 63 | 33 | 70 | 32 |
| V2 = /ɪ/ | E - S1 | non | | + | | ++++ | |
| | E - S2 | non | | ++ | | + | |
| | S1 - S2 | non | | non | | non | |
| V1 = lax | E | 80 | 26 | 111 | 36 | 88 | 24 |
| | S1 | 81 | 23 | 92 | 35 | 81 | 33 |
| | S2 | 86 | 25 | 101 | 42 | 68 | 36 |
| V2 = /ɪ/ | E - S1 | non | | + | | non | |
| | E - S2 | non | | non | | ++ | |
| | S1 - S2 | non | | non | | non | |

/ə/ is approximately correct, but the duration used for final /ɪ/ generally too short. The average duration of /ə/ and /ɪ/ in the whole material is 78 vs. 88 msecs respectively in Group E, 82 vs. 71 msecs in Group S1 and 85 vs. 69 msecs in Group S2. Thus Finns produce a shorter /ɪ/, in accordance with the universal tendency for close vowels to be shorter, while English speakers produce a clearly longer /ɪ/. The longer duration of final /ɪ/ probably serves the purpose of greater distinction between the two vowels but many linguists have also analyzed it as a tense vowel (eg. Chomsky & Halle 1968).

The influence of the preceding syllable upon the final vowel is summarized in Table 3.

Table 3. A comparison of vowel durations in syllables following lax vs. tense vowels of English

| | E | S1 | S2 | |
|---|---|---|---|---|
| /tense/ /lax/ | 71<br>80 | 71<br>84 | 75<br>84 | $V_2$ = /ə/ |
| /tense/- /lax/ | non | non | non | |
| /tense/ /lax/ | 88<br>88 | 60<br>81 | 68<br>70 | $V_2$ = /ɪ/ |
| /tense/- /lax/ | non | ++ | non | |

It can be seen that because of the various, partly conflicting influences, the erroneous production due to the influence of the preceding syllable manifests itself in certain positions only: in words ending with /ɪ/ and in only one informant group.

On the whole, there are two tendencies that can be detected in the pronunciation of Finns. One is the influence of the preceding syllable. The other is the tendency to use a duration that is too short. The latter seems to be due to a wrong interpretation of the timing rules of English. The vowels are usually shortened when unstressed. Some of the Finnish students seem to have a rule that shortens all unstressed vowels, regardless of their position. English speakers have a rule that lengthens final vowels,[1] and this rule seems to overcome the shortening rule (cf. Wiik 1965:134; Delattre 1969:292). Thus for example the average duration of a lax V1 in words ending with /ə/ was 82 msecs, while the duration of V2 was 80 msecs. The duration of the unstressed vowel was thus practically equal to the duration of the

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[1] Final lengthening seems to be a universal phenomenon; see eg. Lindblom 1968; Nooteboom 1972.

stressed vowel. It can be even longer, as the durations of vowels in words ending with /ɪ/ show: the average durations of a lax V1 was 80 msecs while the average duration of V2 was 88 msecs.

QUALITY

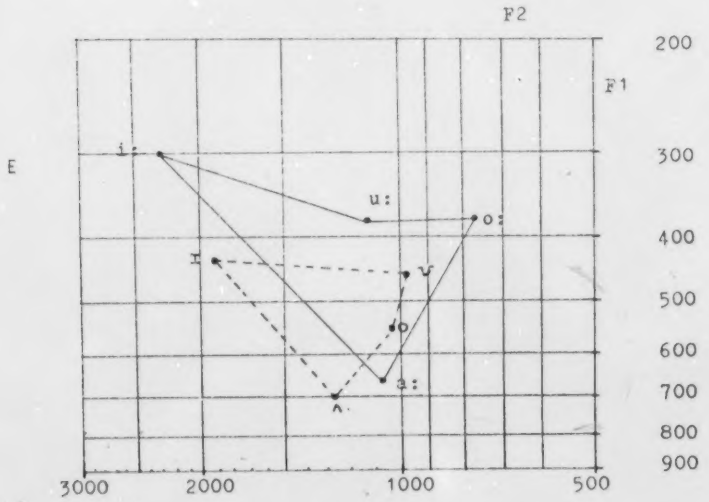
One of the factors of vowel reduction is said to be the centralized quality of the reduced vowels, ie. the close association with acoustical neutral vowel. In the following the reduced vowels of English are considered from this poinf of view. The quality of the stressed vowel is often called a full vowel quality. It cannot, however, represent a target value of vowel since also stressed vowels are influenced by the environment. Tense vowels represent more characteristically the full vowel quality, since lax vowels are inherently more reduced, or closer to neutral vowels in both English and Finnish (cf. Stetson 1951:43; Wiik 1965:59). The interrelation of tense and lax vowels is shown in Table 4.

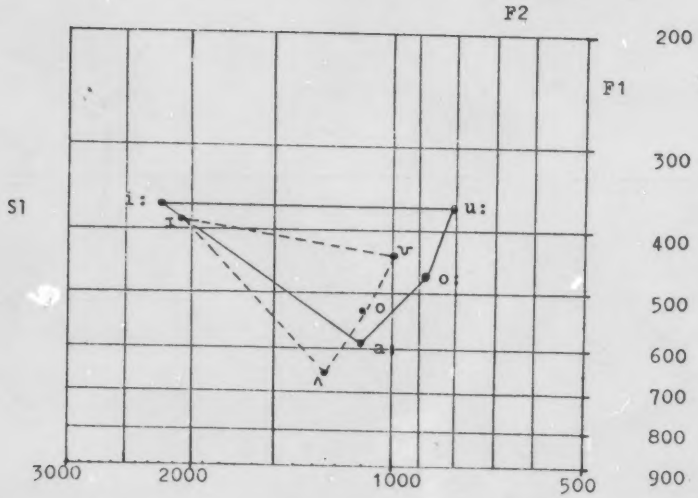
Table 4. Comparison of the formant frequencies of certain tense and lax vowels.

| | F1 | | F2 | | F3 | |
|---|---|---|---|---|---|---|
| | /i:/ | /ɪ/ | /i:/ | /ɪ/ | /i:/ | /ɪ/ |
| E | 300 | 440 | 2340 | 1900 | 2850 | 2600 |
| S1 | 370 | 390 | 2220 | 2080 | 2700 | 2660 |
| S2 | 320 | 360 | 2160 | 2170 | 2880 | 2770 |
| | /u:/ | /ʊ/ | /u:/ | /ʊ/ | /u:/ | /ʊ/ |
| E | 380 | 460 | 1140 | 980 | 2400 | 2430 |
| S1 | 370 | 430 | 830 | 980 | 2610 | 2465 |
| S2 | 410 | 415 | 820 | 840 | 2730 | 2550 |
| | /o:/ | /o/ | /o:/ | /o/ | /o:/ | /o/ |
| E | 375 | 560 | 690 | 1010 | 2560 | 2550 |
| S1 | 470 | 520 | 890 | 1100 | 2475 | 2460 |
| S2 | 500 | 490 | 940 | 1090 | 2575 | 2600 |
| | /ɑ:/ | /ʌ/ | /ɑ:/ | /ʌ/ | /ɑ:/ | /ʌ/ |
| E | 650 | 700 | 1075 | 1290 | 2560 | 2560 |
| S1 | 590 | 650 | 1130 | 1260 | 2360 | 2450 |
| S2 | 710 | 720 | 1240 | 1280 | 2500 | 2450 |

On the whole, the effect of centralization seems to be greater in Group E. The students in Group S2 seem to use nearly identical qualities for tense and lax vowels. It seems that English speakers realize the laxness of vowel mainly in terms of openness. Thus for high vowels F1 is raised and F2 is lowered. For non-high vowels both F1 and F2 are raised. Finnish speakers, on the other hand, seem to be affected by the frontness of the vowel: they raise F2 for back vowels and lower F2 for front vowels. It may be noted that lax vowels may not always be literally closer to a neutral vowel. Thus, for example, all groups raised F1 when producing a lax /ʌ/; ie. the value of F1 was getting further from that of the neutral vowel. The above results are also shown as formant charts (Figure 1) for a better illustration of the processes discussed here.

Figure 1. The formant positions of certain tense (——) and lax (---) vowels of English as produced by English speakers (E), students of English (S1) and other students (S2).




F2
F1
S1
i:
ɪ
u:
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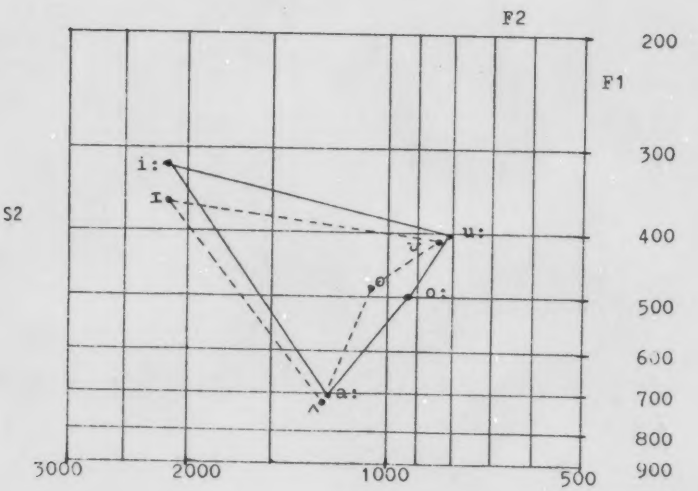
o:
o
a:
ʌ
200
300
400
500
600
700
800
900
3000
2000
1000
500


F2
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S2
i:
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200
300
400
500
600
700
800
900
3000
2000
1000
500

A crucial question in the discussion of the centralization is the starting point, or the point of comparison. From what position are the vowels centralized? For /ɪ/ we can define a lax average value, but it is more difficult for /ə/. In the following the question is considered in the light of some textbook examples. Usually /ə/ has been described as obscured, murmured, dark, etc. Articulatorily it has been described as having a central tongue position and neutral lip rounding (see eg. Gimson 1966:118-119; Lehtonen, Sajavaara and May 1977:117-118; Stubelius 1968:42). Acoustically, its formant values are near to those of a neutral vowel. It could be suggested that in English /ə/ is an independent, systematic vowel, not simply a variant for all unstressed or sloppily pronounced sounds. It seems to be related to the stressed /ɜ:/ since they have arisen from similar contextual environments: the following /r/ has originally caused a centralization of certain vowels, and when /r/ has disappeared, the quality has persisted. Whether the phoneme /ə/ includes vowels derived from other sources is somewhat unclear. The status of endings like -ər, etc. seems to be slightly ambiguous. and there is probably some variation due to presence vs. absence of secondary stress. The phoneme /ə/ has several allophones: Wiik (1965:136), for instance, gives seven different variants and Jones (1967:92-93) three. Usually it is agreed that the final variant is more open.

As regards the quality of English /ə/, it can be presumed that Finnish students either tend to use the vowel quality implied by orthography, or tend to use the nearest equivalent in the Finnish vowel paradigm, viz. /ö/. The influence of orthography is not considered here, but it is undoubtedly considerable. Here all test words were chosen to be "easy", so that the students had to know only some obvious rules of pronunciation. The substitution of /ö/ for /ə/ is, according to Enkvist (1963:47), a typical error of a Finnish student of English. The English vowel is, however, rather remarkably different from the Finnish one: /ə/ is central, while /ö/ is front, /ə/ is a little lower than /ö/ and, above all, it has a neutral lip position while /ö/ is rounded. The average formant values of the vowel /ə/ in this material are shown in Table 5.

Table 5. The average formant positions of V2 = /ə/ of three word groups

| Hz | F1 | F2 | F3 |
|---|---|---|---|
| E | 480 | 1480 | 2600 |
| S1 | 470 | 1510 | 2400 |
| S2 | 470 | 1460 | 2390 |

The tendency of Finns to have generally lower formant frequencies is clearly reflected in the results. The F3, especially, is consistently lower with Finnish speakers (the lowering is attested by the statistical significance: ++++). The behaviour of F3 probably reflects the fact that Finns produce a rounded vowel. It could be suggested that students might be told to use a more [a]-like quality in final position at least, in order to avoid the lip rounding (cf. Erämetsä 1951).

As regards the quality of unstressed, final /ɪ/, the comments in textbooks are contradictory. Jones (1967:68) and Johansson (1972:21) argue that final /ɪ/ is particularly open, or closer to /e/. Wiik's (1965:135-138) results show that final /ɪ/ is more closed, or closer to /i:/. Gimson (1966:97) notes that there is a lot of variation in the pronunciation of final /ɪ/: it may be centralized, or it may be replaced by /i:/. The results of the present study show that all English informants preferred a quality that is more close than open. The results are shown in Table 6.

Table 6. The average formant positions of V2 = /ɪ/ of two word groups

| | $V_1$ = /tense/ | | | $V_1$ = /lax/ | | |
|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 |
| E | 325 | 2120 | 2645 | 350 | 2155 | 2670 |
| S1 | 385 | 1980 | 2565 | 385 | 2020 | 2600 |
| S2 | 395 | 2070 | 2720 | 355 | 2060 | 2725 |
| E - S1 | ++++ | ++++ | non | +++ | ++++ | non |
| E - S2 | ++++ | non | non | non | + | non |
| S1 - S2 | non | non | +++ | + | non | + |

In both groups students of English have a significantly lower F2 than native speakers, and also significantly higher F1. The students of English have been taught to use a different quality for tense and lax vowels, and thus they use the lax quality they have learned in final position as well. English speakers, however, use a quality nearer to the tense vowel, as can be seen in Table 7.

Table 7. A comparison of formant positions of stressed /i:/, stressed /ɪ/$_1$ and unstressed /ɪ/$_2$.

| | /i:/ | /ɪ/$_1$ | /ɪ/$_2$ | |
|---|---|---|---|---|
| E | 300 | 440 | 340 | F1 |
| S1 | 370 | 390 | 390 | |
| S2 | 320 | 360 | 380 | |
| E | 2340 | 1900 | 2140 | F2 |
| S1 | 2200 | 2080 | 2000 | |
| S2 | 2160 | 2170 | 2070 | |
| E | 2850 | 2600 | 2660 | F3 |
| S1 | 2700 | 2660 | 2590 | |
| S2 | 2880 | 2770 | 2720 | |

English speakers use a quality for the final /ɪ/ which lies between the average values of stressed /i ' and stressed /ɪ/. It seems that Finnish students tend to produce a vowel that is too "tense" when stressed and too "lax" when unstressed.

As we have seen, there is a tendency for /ə/ to drift towards a more open position, and for /ɪ/ towards a more closed one, when they are in final position. This is what one would expect precisely in final position, since the strongest need for retaining the opposition occurs just there. Since eg. -*eɾ* and -*y* are both productive endings, it is natural that the distinction between them is preserved.

COARTICULATION

It has been argued that one of the factors that causes reduction is greater contextual influence, or coarticulation. On the level of speech production, speech sounds are not the invariant entities that they are on the level of perception. Speech flow cannot be segmentated unambiguously into linguistic units of any kind, eg. phonemes (cf. Kent and Minifie 1977:116). The sounds influence each other and a phonetic feature may be expanded to several segments not originally having this feature. Thus coarticulation can be defined as "the influence of one speech segment upon another; ... the influence of a phonetic context upon a given segment" (Daniloff and Hammarberg 1973:239).

The fact that coarticulation exists implies certain things about the nature of the higher-level programming of speech, ie. the neural events connected with speech processing. As the acoustic and articulatory events seem to be of variant nature, while the perception of speech occurs on the basis of invariant linguistic units, a model for speech processing should be able to explain how the discrete linguistic units and the physical speech continuum are made compatible within the speech programming system.

Basically coarticulation can be either forward or backward. Forward (anticipatory, regressive, right-to-left) coarticulation occurs, according to Kent and Minifie (1977:117), when articulatory adjustment for a segment is started during an earlier segment. One example of forward coarticulation is anticipatory lip rounding in French, studied by Benguerel and Cowan (1974). They found that upper lip protrusion for a rounded segment can start as much as six segments in advance, eg. already on the initial consonant in the combination /strstry/. An anticipatory nasalization in English is discussed by Moll and Daniloff (1971), who argue that nasal coarticulation can occur across the word boundary.

The other type of coarticulation is backward or retentive, progressive, left-to-right coarticulation. Here an articulatory adjustment for one segment is carried over to a later segment (Kent and Minifie 1977:117).

Retentive coarticulation can be attributed to inertial factors, ie. to the mechanical slowness of the articulatory mechanism. Thus no hypotheses about the higher-level programming need be made. Anticipatory coarticulation is harder to explain if neural factors are not considered.

A physically later segment can not influence an earlier segment unless the system somehow has information concerning several segments simultaneously. This gives raise to the question of the size of the speech programming unit. Kozhevnikov and Chistovich (1965) have explained anticipatory coarticulation by determining that the basic speech programming unit is a syllable. In their model the minimal unit is an open syllable $(C)^nV$. The articulatory events are organized in syllable-sized chunks. The production process is discontinuous;there is a boundary after a vowel sound. The vowel determines the preceding consonants, and thus explains anticipatory events.

According to the binary model discussed by eg. Moll and Daniloff (1971) speech is programmed in segment-sized units which are given a binary specification (+, −, or unspecified). The anticipatory coarticulation is explained by a scanning device, which looks upon the next specified segment in the sequence, and gives the same specification to all preceding unspecified segments. There seems to be evidence to show that neither the Kozhevnikov and Chistovich theory nor the Moll and Daniloff model is able to explain all coarticulatory phenomena. Thus, for example, coarticulation can occur across syllable boundaries (Moll and Daniloff 1971; Kent, Carney and Severeid 1974; Öhman 1966:151-152), which shows that the model proposed by Kozhevnikov and Chistovich cannot account for all cases of coarticulation. The binary model of Moll and Daniloff has been criticized eg. by Kent, Carney and Severeid (1974). It will presumably be necessary to postulate more than one unit for the speech programming model (for a closer discussion on the relevance of coarticulation to speech programming models, see Kent and Minifie 1977).

One of the most crucial questions from the point of view of the present subject is the notion of target. The notion of coarticulation does not make sense, unless some kinds of inherent properties are postulated for the segment. How can the inherent properties be defined: acoustically, articulatorily, or in some other way? Ohde and Sharf (1975:923) presume that a target is an ideal articulatory position of the vowel produced in isolation. Lindblom argues (1963:1778) that target represents "some physiological invariance". For MacNeilage (1970:190) target is an invariant articulatory (motor or spatial) goal. Kozhevnikov and Chistovich (1965) use the term motor goal: these are stored in the brain, and actual motor commands issued depend both on the motor goals and the state of the articulatory mechanism.

Are targets related to phonemes or some other linguistic entities? Most writers prefer phonemes, but eg. Wickelgren (1969) has proposed an allophonic model. As all possible allophones are listed and stored in the brain, his model would presuppose a vast programming capacity. The model ignores also the fact that many coarticulatory phenomena can be best described by generalized rules, not as single unrelated events. According to Hammarberg (1976), who thinks that coarticulation is a totally linguistic process, governed by low-level phonological rules that link phonology and phonetics together, a speaker actually hits the target when producing a coarticulated form. Thus the speech mechanism does not miss the target, but does what it is told to do by the brain. Perhaps some justification for Hammarberg's views is offered by the fact that coarticulatory rules are not universal: if coarticulation could be accounted by the physiological factors, the rules would have to be of a more universal nature. It seems to be probable, in fact, that coarticulation rules are to some extent dialectal, or idiolectal (cf. eg. Bladon and Al-Bamerni 1976; Kent, Carney and Severeid 1974).

What is the influence of coarticulation upon vowel reduction? It has been argued that reduced vowels coarticulate more strongly with the surroundings (Nord 1974:149; Tiffany 1959; Shearme and Holmes 1961; Stevens and House 1963). The surrounding consonants do have a centralizing effect upon vowels in general, as was confirmed by Joos (1948). The place of articulation of a consonant affects the vowel, too, as was noticed within the framework of locus theory (eg. Cooper et al. 1952; Delattre et al. 1955). Locus theory has been criticized by eg. Öhman (1966:155) who argued that the transitional pattern of a vowel does not depend entirely on the consonantal context, and that vowels, also, may influence other vowels. The average consonantal effect is, however, according to Delattre (1969:299-300) the shift of the F2 of the vowel towards the locus of the adjoining consonant. As regards the direction and causes of consonantal influence upon the vowel, Ohde and Sharf (1975:925) give three possible models. The first is an anticipatory scanning model: the vowel is modified to approach the place of articulation of the following consonant. The second is a retentive mechano-inertial model: the rapid shift from a consonantal to a vocalic position is prevented by inertia. The third model is a retentive compatibility model: the vowel is modified to approach

the place of articulation of the following consonant. According to Ohde and Sharf vowel reduction (here: the consonantal influence upon vowels) is caused mainly by the retentive models: a vowel in a CV syllable would be more apt to reduce than a vowel in VC syllable. Data supporting this hypothesis is offered by the study of MacNeilage and DeClerk (1969) which showed that the coarticulation in CVC structures was stronger between the segments in CV part of the item than in the VC part.

The quality of vowels can also be affected by their position: eg. following or preceding rest position. According to Nord (1975:153-154) final unstressed vowels coarticulate strongly with the rest position of the vocal tract. Thelin (1971:149) notes that in Russian vowel reduction can be caused by a following or preceding rest position. Öhman's (1966: 154) study of Swedish vowels shows that in some vowels the formant frequencies are more central in final position than in initial position. The final reduction can be explained either as the influence of the preceding vowel (cf. Ohde and Sharf 1975) or as the influence of the following state of the vocal tract (cf. Nord 1975), and the two-fold influence is probably the reason why final vowels often tend to reduce.

The quality of vowels can also be influenced by other vowels. The overall vocalic influence in VCV structures was studied by Öhman (1966) whose results indicate that speech production is in fact a series of vowel gestures with intervening consonants. In another study of VCV structures Fant et al. (1970:10) argue that the course of F2 within the final vowel seems to be depending on the quality of the initial vowel. According to Daniloff and Hammarberg (1973:244) the effect of the preceding vowel upon the final one is the adjustment of openness: an open V1 causes the V2 to be more open. The vocalic coarticulation can thus reach across a syllable boundary.

The final vowel can thus be influenced by the preceding vowel, the preceding consonant, or by the following rest position. The aim of this study was to study the vocalic influence. The Figures 2-3 show the formant positions of certain tense and lax vowels and the formant positions of the following vowel /ə/. The numerical values of the formants are shown in Table 8.

Figure 2. Formant positions of initial tense vowels and the following vowel /ə/. Formant positions of the initial and final vowels are connected with a dotted line. Informant groups E (English), S1 (students of English), S2 (other students).

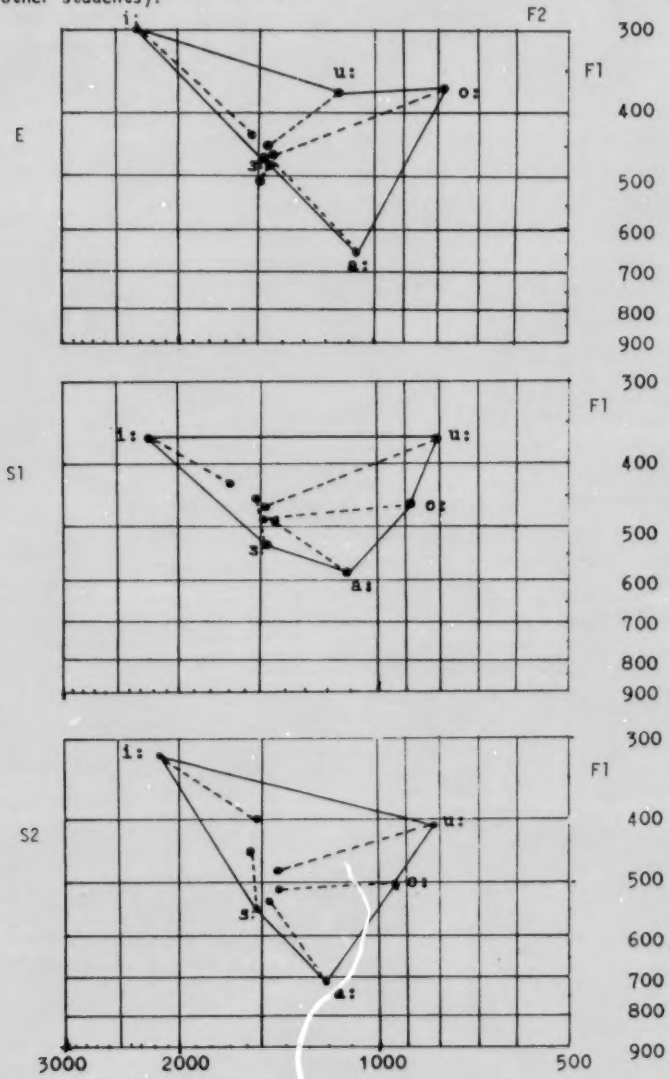


Figure 3. Formant positions of initial lax vowels and the following vowel /ə/. Formant positions of the initial and final vowels are connected with a dotted line. Informant groups E (English), S1 (students of English), S2 (other students).

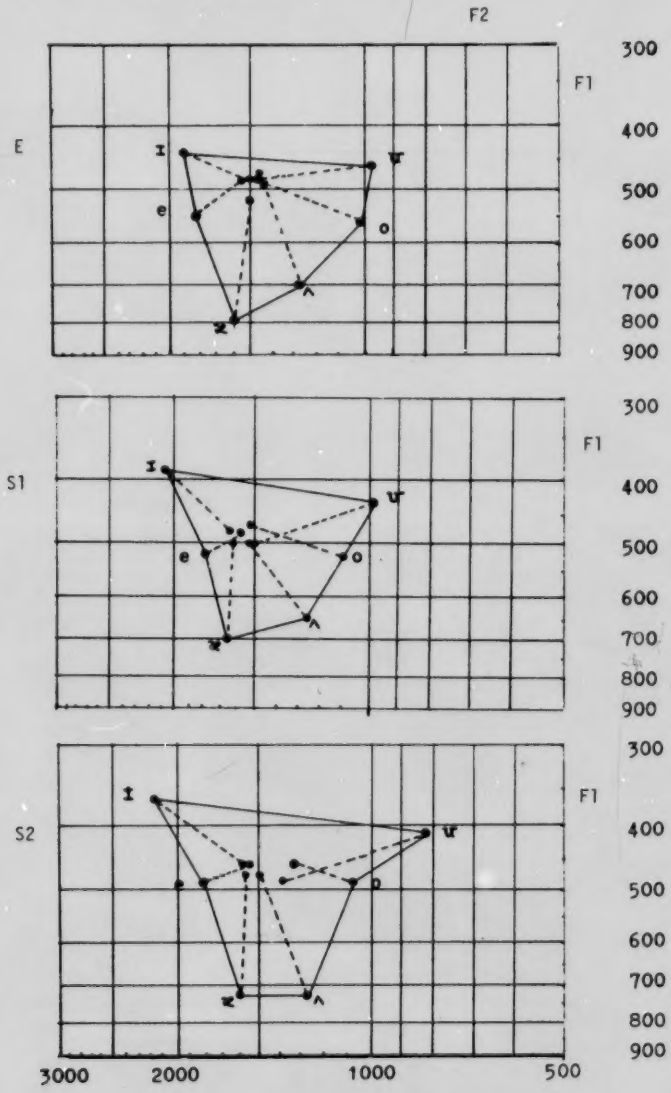


Table 8. Formant frequencies (F1, F2, F3) of the final /ə/ classified according to the initial vowel

V2 = /ə/

| V1 | ɪ | e | æ | ʊ | o | ʌ | |
|---|---|---|---|---|---|---|---|
| E | 480 | 480 | 520 | 480 | 490 | 470 | |
| S1 | 490 | 480 | 500 | 460 | 460 | 500 | F1 |
| S2 | 460 | 460 | 470 | 490 | 450 | 470 | |
| E | 1500 | 1510 | 1500 | 1490 | 1420 | 1430 | |
| S1 | 1640 | 1590 | 1610 | 1520 | 1520 | 1530 | F2 |
| S2 | 1590 | 1570 | 1580 | 1390 | 1425 | 1500 | |
| E | 2670 | 2640 | 2650 | 2660 | 2400 | 2640 | |
| S1 | 2470 | 2450 | 2510 | 2430 | 2360 | 2490 | F3 |
| S2 | 2450 | 2460 | 2460 | 2410 | 2350 | 2480 | |

V2 = /ə/

| V1 | i: | ɜ: | ɑ: | u: | o: | |
|---|---|---|---|---|---|---|
| E | 440 | 510 | 480 | 450 | 470 | F1 |
| S1 | 430 | 450 | 490 | 470 | 490 | |
| S2 | 400 | 450 | 450 | 480 | 510 | |
| E | 1560 | 1500 | 1470 | 1460 | 1460 | F2 |
| S1 | 1670 | 1530 | 1460 | 1490 | 1475 | |
| S2 | 1530 | 1570 | 1480 | 1440 | 1440 | |
| E | 2680 | 2700 | 2660 | 2450 | 2650 | F3 |
| S1 | 2400 | 2600 | 2350 | 2390 | 2425 | |
| S2 | 2450 | 2390 | 2370 | 2340 | 2425 | |

It can be seen that there is a slight attraction towards the preceding vowel quality in each informant group. The influence of the initial tense vowel upon the final vowel is considerable in the group of other students (S2). There seem to be two areas of attraction: after a front vowel the final vowel is more front and high, and after a back vowel the final vowel is more retracted and low. The initial lax vowel seems to exert a slightly different influence: the decisive factor seems to be the behaviour of F2, while F1 is kept relatively constant. Table 9 shows the effect of certain vowel dimensions upon the final vowel.

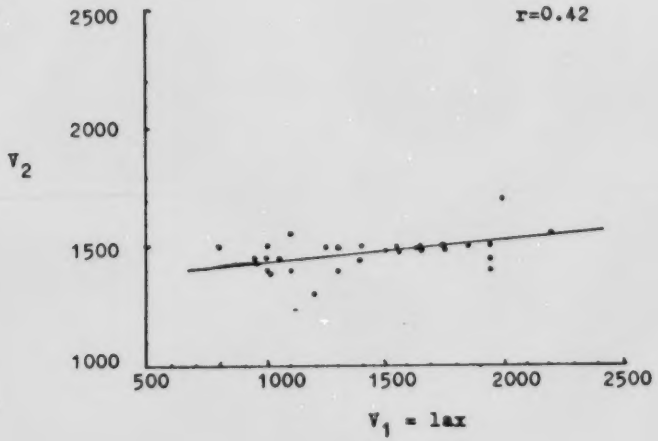
Table 9. The formant frequencies of the final /ə/ classified according to the nature of the initial vowel

| $V_2$ = /ə/ | | | | |
|---|---|---|---|---|
| Group / $V_1$=tense | E | S1 | S2 | |
| high | 445 | 450 | 440 | F1 |
| mid | 490 | 470 | 480 | |
| low | 480 | 490 | 450 | |
| front | 475 | 440 | 425 | F1 |
| back | 470 | 485 | 485 | |
| front | 1530 | 1600 | 1550 | F2 |
| back | 1465 | 1475 | 1455 | |
| labial | 2550 | 2410 | 2380 | F3 |
| illabial | 2680 | 2450 | 2400 | |

| Group / $V_1$=lax | E | S1 | S2 | |
|---|---|---|---|---|
| high | 480 | 495 | 465 | F1 |
| mid | 485 | 470 | 455 | |
| low | 495 | 500 | 470 | |
| front | 495 | 490 | 465 | F1 |
| back | 480 | 490 | 470 | |
| front | 1505 | 1615 | 1580 | F2 |
| back | 1445 | 1525 | 1435 | |
| labial | 2530 | 2395 | 2380 | F3 |
| illabial | 2650 | 2480 | 2465 | |

The table shows that English speakers tend to raise F1 slightly, if the preceding vowel is non-high. Finnish speakers tend to lower F1 if the initial vowel is front. F2 displays more variation. If the initial vowel is back, all informants lower F2. It also seems that F3 is affected by the initial vowel: after a round vowel it seems to be lowered. For Finnish speakers the effect is very slight. When the initial vowel is lax, the results are slightly different. The effect of the initial vowel on the F1 of the second vowel is small. F2 is, however, clearly raised after front vowels. The average value of F2 of the final vowel is significantly smaller (+++) when the proceding vowel is back in two informant groups: English speakers and Students (S2). As the behaviour of the second formant seemed to be of some significance, the correlation between the second formants of both V1 and V2 were also calculated. The results are seen in Figures 4-6. The correlation was calculated separately for tense and lax vowels, as their influence seemed to be different.

Figure 4. The correlation between F2 of the initial vowel ($V_1$) and F2 of the final vowel ($V_2$) shown as a diagram; native speakers of English (E).



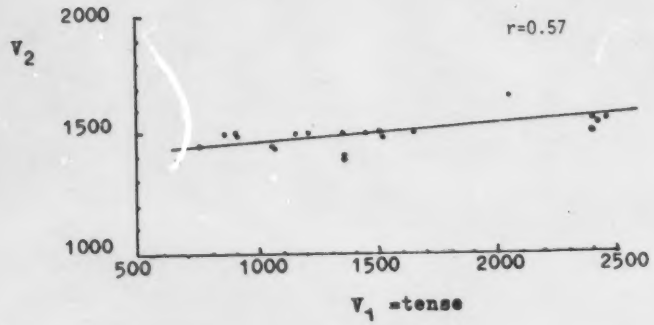
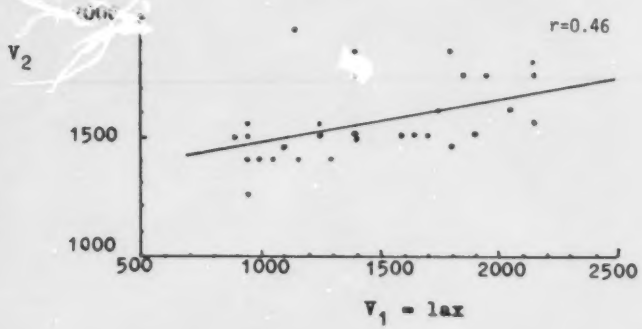



Figure 5. The correlation between F2 of the initial vowel ($V_1$) and F2 of the final vowel ($V_2$) shown as a diagram; Finnish students of English (S1).



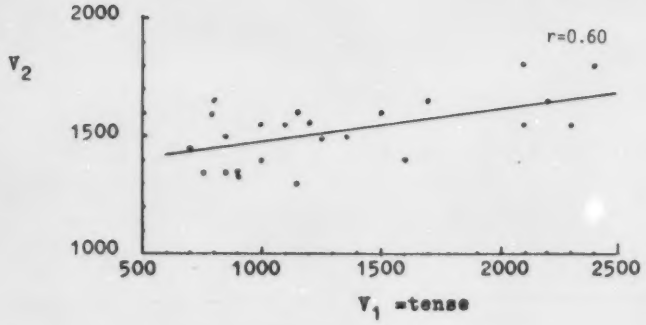
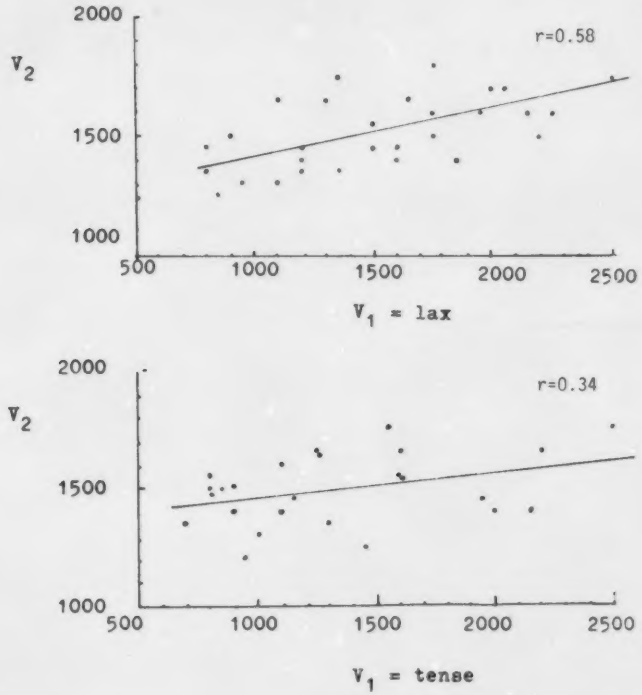



Figure 6. The correlation between F2 of the initial vowel ($V_1$) and F2 of the final vowel ($V_2$) shown as a diagram; Finnish students (S2).




The data for English speakers shows that there seems to exist a positive correlation between the second formants of initial and final vowels. The correlation is stronger when the preceding vowel is tense (r=0.57 with tense initial vowel; r=0.46 with lax initial vowel). Students of English (S1) appear to have the same tendency. There is a stronger correlation when the initial vowel is tense (r=0.60 vs. r=0.46). Other Finnish students have a stronger correlation between the vowels when the initial vowel is lax (r=0.58 vs. r=0.34). One important fact should be noticed. There seemed to be a substantial amount of individual variation as regards the

coarticulatory influence between the two vowels, although some facts appeared to be characteristic for British speakers, some others for Finnish speakers. Further, one has to be careful in drawing any conclusions from the coarticulatory processes in Finnish, since the material consisted only of English items. The differences in the productions of native speakers and Finns may reflect only the fact that Finns are speaking a foreign language. It is quite possible that the features of their "interlanguage" are different from English and from Finnish. Also, the material includes vowel combinations, which, if interpreted in terms of Finnish phonology, are strictly ungrammatical: eg. *potter* = *potö. The above results only apply to /ə/. The influence of the initial vowel upon /ɪ/, however, proved to be rather similar. The summary of the influence is given in Table 10.

Table 10. The formant frequencies of the final /ɪ/ classified according to the nature of the preceding vowel

| | $V_2$ | | | |
|---|---|---|---|---|
| $V_1$ \ Group | E | S1 | S2 | |
| high | 310 | 355 | 370 | F1 |
| non-high | 340 | 410 | 410 | |
| front | 2155 | 2055 | 2060 | F2 |
| back | 2100 | 1920 | 2080 | |
| labial | 2595 | 2530 | 2680 | F3 |
| illabial | 2680 | 2590 | 2750 | |

/ɪ/ also seems to be influenced by the openness of the preceding vowel. F1 is higher after a non-high vowel, and F2 is raised after a front vowel. Finnish students do not have this tendency, however. If the initial vowel is rounded, there is a slight lowering tendency. In general, the results are in accordance with the data from /ə/.

Summing up the results for coarticulation, it may be argued that certain vocalic dimensions can be retained through the whole VCV structure.

The initial vowel seems to determine the quality of the final vowel to some extent. It is also possible that stressed vowels tend to determine the quality of the unstressed ones. This could not, however, be studied with this material.

CONCLUSION

The aim of the present study was to investigate the difficulties met by Finnish students when producing unstressed vowels of English. The scope of the study was limited to final vowels. Phonologically, Finnish and English differ radically. It was noted, however, that there is a tendency in many languages to neutralize the oppositions between vowels in unprominent position. It was suggested that in English this tendency is realized in terms of vowel reduction, and in Finnish, partly, in terms of vowel harmony.

The phonetic investigation included the measurement of duration, vowel quality, and the degree of coarticulation between the vowels. As regards duration, it may be noted that students tend to produce a final vowel that is too short, or that they tend to use two different durations depending on the length of the preceding syllable. The differences in vowel quality were also considerable between English and Finnish speakers. Generally, Finnish speakers tend to produce a rounded vowel for /ə/ and an /e/-like, or too lax vowel for the unstressed /ɪ/. The last error may be due to the fact that Finnish students exaggerate the difference between tense and lax vowel qualities. It may also be due to the fact that they use the same quality for /ɪ/ in every position, whereas the English speakers had different qualities for final and non-final variants. The results from the measurement of coarticulation are necessarily very tentative. It would seem, however, that a positive correlation between the initial and the final vowel can be established. Thus the initial, or stressed vowel would seem to have an influence on the final one. The existence of such influence is common to each informant group. The actual manifestation may be different. It may be noted again, that though the coarticulation between the stressed and unstressed vowels may be universal, the rules may be language-specific, dialectal and idiolectal.

How can the results be applied in practice? It is difficult – perhaps impossible – for an adult to achieve a native-like pronunciation of a new language. That is why the adult teaching should emphasize the cognitive

side of language learning. What cannot be achieved by imitation, can perhaps be achieved by understanding theoretically a particular process: eg. the variation in the duration of vowels, or the phonetic difference between Finnish /ö/ and English /ə/. This may not, however, apply to coarticulatory rules. They may be learnt best by listening how a native speaker "sounds". It may also be unnecessary to learn them, or some of them.

Finnish students seem to have difficulties even in fairly simple structures of English. This concerns both the duration and the quality of segments. The main function of vowel reduction seems to be the correct adjustment of the prominent and unprominent elements in a sentence. If this is ignored, the fluency of the whole utterance is jeopardized.

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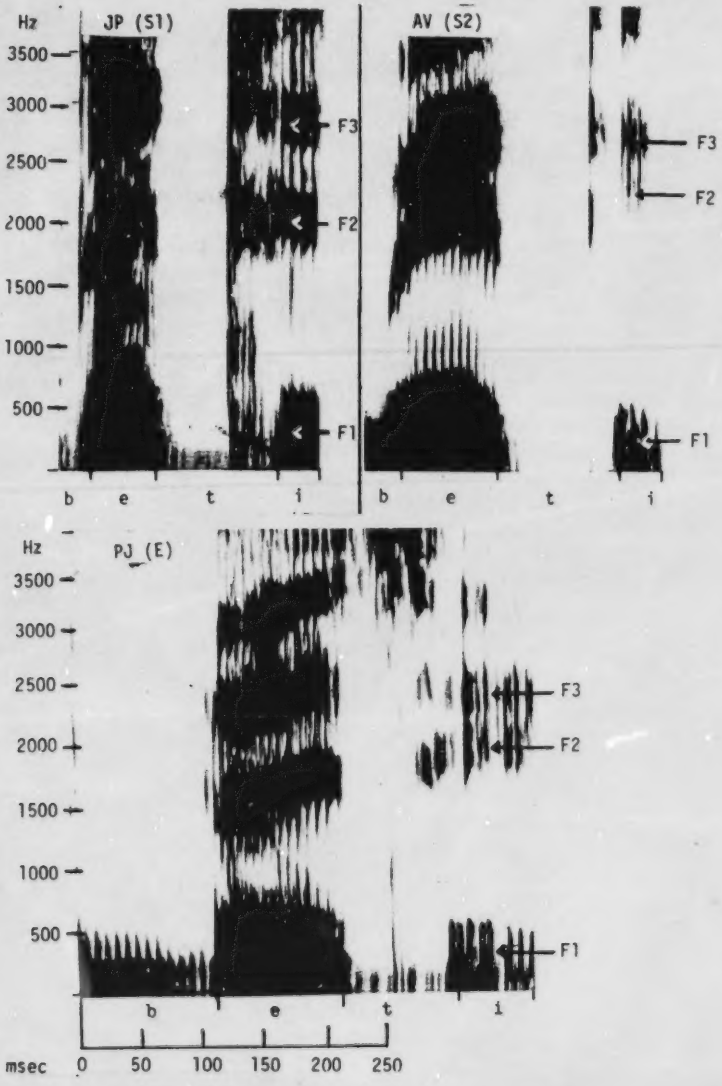
Appendix. Sample spectrograms of the segmentations made.
E = English speaker, S1 = Finnish student of English,
S2 = Finnish speaker.



# THE ENGLISH /ptk/-/bdg/ DISTINCTION: DATA AND DISCUSSION

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## 1. Acoustic Correlates

The major acoustic correlates of the English /ptk/-/bdg/ distinction are well known and uncontroversial and therefore we shall only briefly mention the characteristics of the two sets in the word initial, word medial and word final positions, without making explicit reference to published data. We shall assume that the word initial and final positions are at the same time also utterance initial and final, respectively. The effects of stress, emphasis, position in the sentence etc. will be excluded although, admittedly, they interact with the more segmental determinants of the opposition. Temporal differences between the two sets will be dealt with separately in section 3.5. below.

In the word initial position the distinction is mainly manifested by a presence of aspiration in /ptk/ vs. its absence in /bdg/, both sets normally having voiceless occlusions, although in the latter the voicing of the occlusion is optional. In addition to having aspiration qua a lag in the onset of voicing /ptk/ are also characterized by a stronger (homorganic) explosion noise than /bdg/. The difference in the timing of the voice onset causes also other concomitant acoustic effects, e.g. the more marked rising of the first formant (F1) of the adjacent vowel in the case of /bdg/ and the first formant

cutback in /ptk/, and the fact that in general a larger portion of the formant transitions are voiceless and masked by aspiration noise in /ptk/ and therefore perhaps less useful as identification cues for the /place of articulation/ feature than in /bdg/ in which the formant transitions are voiced and more clearly audible (although this is counterbalanced by the stronger homorganic explosion burst in the former). It remains to be said that the initial pitch of the following vowel is often higher for /ptk/ than for /bdg/. Some of the differences just mentioned accompany the distinction, with appropriate modifications, also in the other positions.

Medially, between vowels, /bdg/ are usually voiced throughout the occlusion and the explosion burst is weak. In /ptk/ the occlusion is voiceless, followed by a stronger explosion burst, the duration of aspiration depending, among other things, on the proximity of stress.

Word finally the two sets are mainly distinguished by the duration of the preceding vowel: before /bdg/ the vowel has a much longer duration then before /ptk/. The voicing of the occlusion of /bdg/ in this position is optional, ranging from no voicing to full voicing, although excessive voicing in this position is rare. The occlusion in /ptk/ is voiceless. If the stop is released, the burst is again stronger in /ptk/.

## 2. Stop Production and the Mechanisms of Voice Regulation and Aspiration

### 2.1. Voiced Stops

According to the myoelastic-aerodynamic theory of phonation (see e.g. van den Berg 1968, Ladefoged 1973, 1975, Söderberg 1976) two conditions must be fulfilled for vocal fold vibration to occur: firstly, the vocal folds must be appropriately positioned (in the slightly adducted position, the so-called voice state, see e.g.

Ladefoged 1973), and secondly, a sufficient transglottal flow of air must be provided. Given the fulfilment of these two conditions, the application of the Bernoulli effect will cause spontaneous vocal fold vibration. The presence vs. absence of a relatively free passage of air through the supraglottal cavities of the vocal tract is, of course, the basis for the division of consonants into resonants and obstruents, respectively. The aerodynamic conditions prevailing in the vocal tract in obstruents (and particularly during the occlusion of stops) being antagonistic to the transglottal flow of air and thus to voicing, how can the occurrence of glottal vibrations during the occlusion of /bdg/ be explained, assuming the correctness of the myoelastic-aerodynamic theory?

The problem, of course, consists of finding the mechanisms that are used to maintain a sufficient transglottal pressure drop while the vocal tract, from the lungs to the constriction, forms a closed system with essentially two cavities, the subglottal and the supraglottal one, connected by a valve, the glottis. Rothenberg (1968: 91) has calculated that, without any special adjustments affecting the volumes of the two cavities, the equalization of the initial pressure difference would occur in about 4 msec and that, allowing for a passive expansion of the pharyngeal walls, a prolongation of voicing up to 20-30 msec after the beginning of the occlusion could be accounted for. However, more powerful mechanisms must be looked for to explain the often longer voiced closure durations of /bdg/.

Perkell (1965) conducted X-ray motion picture studies that indicated a greater pharyngeal cavity width during the articulation of /d/ as compared to /t/ in English. This finding was interpreted by Perkell (and later by Chomsky and Halle 1968: 325) to imply that in the production of /t/ the walls of the vocal tract are rigid as a result of muscular tension whereas during /d/ the walls are lax and able to expand to permit the

increase of volume necessary for a prolongation of voice during the occlusion. Thus, according to Perkell, the expansion of the pharynx in /d/ would occur passively, as a result of the vocal tract being compliant.

Kent and Moll (1969: 1552), using cinefluorographic films, found out that /bdg/ (in English) are characterized by a lower hyoid bone position and a greater tongue-pharynx width than /ptk/. It was further discovered that there was an actual increase in the volume of the supraglottal cavities during /bdg/, whereas there were smaller increases, no increases at all or a slight reduction in cavity size during /ptk/. However, the authors prefer the explanation that pharyngeal expansion during the voiced stops could occur as a result of an active mechanism (p. 1554). They point out that the changes in vocal tract compliance proposed by Perkell are not very likely in view of the fact that the intraoral pressure is everywhere reported to be higher for /ptk/ than for /bdg/, at least for the initial portions of the occlusion (for a discussion of intraoral air pressure data see section 3.2. below). With regard to the intraoral pressure alone, then, one would rather expect the pharynx walls to be wider apart and the oropharyngeal cavity volume to be larger in /ptk/ and <u>not</u> in /bdg/. Similarly, it can be argued that the tensing of the cavity walls during the occlusion of /ptk/ (which, as the data discussed below indicate, is a claim not very strongly supported by experimental evidence) resulting in a smaller volume of the oropharyngeal cavity would have to be so strong as to overcome the expansive influence of the higher intraoral pressure.

Electromyographic investigations of the muscles involved in pharyngeal cavity expansion (Bell-Berti 1975, Bell-Berti and Hirose 1975) reinforce in general the already familiar pattern, i.e. /bdg/ are characterized by a pharyngeal cavity expansion while their voiceless cognates are not. More specifically, the authors try to assess

whether a passive or an active expansion takes place in the voiced stops. However, their interpretation of the terms 'active' and 'passive' differs, it seems to me, from the use of these terms by Rothenberg. In Rothenberg (1968) a passive expansion is one that occurs as a result of the influence of the steadily growing intraoral air pressure on the compliant structures of the oropharyngeal cavity, without the interaction of any muscular activity of the structures themselves. In Bell-Berti (1975), on the other hand, a passive expansion is one that results from the relaxation of the activity of certain pharyngeal wall muscles, while an active expansion is one that results from an increase in the activity of certain other muscles. Thus, in this framework, the possible influence of the intraoral pressure does not come to play at all. Bell-Berti found out that, within the framework used, it is not possible to predict whether a given subject will exercise active or passive control, or a combination of these, for variations in the volume of the supraglottal cavity for voicing distinctions in English. This finding Bell-Berti interprets to show that the feature [± tense] , propounded by Chomsky and Halle (1968), is inadequate for describing the pharyngeal volume changes concomitant with voicing distinctions. The electromyographic investigations of Minifie *et al*. (1974) showed an apparent inhibition of pharyngeal constrictor muscles in /b/ and considerably less reduction for /p/. The authors mention the possibility to interpret this finding to support the position that the transglottal pressure differential is actively controlled via changes in the oropharyngeal volume, these changes contributing to the maintenance of vocal cord vibration during the occlusion of voiced stops. But the authors are cautious to point out that to document an active enlargement of the pharynx one would have to observe reciprocal activity in the muscles antagonistic to the pharyngeal constrictors. However, if we reinterpret the findings of Bell-Berti and Minifie *et al*., defining, in accordance with Rothenberg

(1968), passive expansion as one caused by intraoral pressure alone and active expansion as one involving additional muscular activity of any kind, whether a relaxation or inhibition of some muscles or an increased activity of some other muscles, we can conclude that these results give further support to the hypothesis of an active expansion of the supraglottal cavity in /bdg/ although, as the result obtained by Bell-Berti indicate, the actual mode of muscle activity is complex and may vary from person to person.

On a priori theoretical grounds, too, the hypothesis of a passive expansion (i.e. one caused by intraoral pressure alone) seems less attractive as it implies yet another obstruction to the transglottal flow of air while the problem, as was stated at the outset of the present section, is to find the mechanisms that facilitate the prolongation of the transglottal pressure differential. At any rate, the relative volumes of the subglottal and supraglottal cavities put a limit to the effectiveness of even an active use of this mechanism if not accompanied by additional, or concomitant, mechanisms.

Another possibility of prolonging the transglottal air flow is to lower the entire larynx. It may be pointed out that this mechanism, in contrast to the ones discussed so far, could ensure sustained phonation even if the subglottal and intraoral air pressures were equal at the beginning of the occlusion. The larynx at large can act as a piston, decreasing the volume of the subglottal cavity and increasing that of the supraglottal one, thus creating a transglottal pressure drop. This mechanism is in fact similar to the one used in implosive stops although these, in contrast to the English stops, involve a glottalic ingressive airstream mechanism.

We have already mentioned the finding of Kent and Moll (1969) that the hyoid bone is lowered during the occlusion of English /bdg/. The authors interpret the finding to support the view that the larynx is drawn

downward in these stops and that, in view of the large masses involved, the depression must occur as a result of an active mechanism. More specifically, the authors suggest (p. 1554) that the hyoid bone is depressed by an activation of the extrinsic musculature of the larynx and that the depression usually co-occurs with pharyngeal expansion which, as was discussed above, is at least in part controlled by the constrictor muscles of the pharyngeal walls. Thus pharyngeal expansion and the enlargement caused by a depression of the larynx are perhaps not independently controllable gestures. From a functional point of view, at least, both serve the same purpose in this particular context.

Further indirect evidence for larynx lowering in English voiced stops is provided by Netsell (1969) who, on the basis of the essentially invariant subglottal pressure contour observed in the occlusion phase of /d/ suggests that the observed continuous transglottal pressure drop is the sole result of a volume increase in the supraglottal cavity. More directly, the larynx movement measurements using the thyroumbrometer by Ewan and Krones (1974) indicate, among other things, that voiceless stops (in English, Thai, French and Hindi) generally have a higher larynx position than corresponding voiced stops, with this difference in position being greater at or near the end of the stops. The last observation, it may be pointed out, answers well the demand for a prolonged transglottal pressure drop.

The remaining mechanism is incomplete velopharyngeal closure, i.e. a leakage through the nasal cavities, mentioned by Rothenberg (1968: 99-106). The only information concerning the possible use of this mechanism in English available to the present writer is the observation of Kent and Moll (1969: 1555) that one of their subjects gave evidence that velopharyngeal opening is more common during voiced than voiceless stops.

So far only mechanisms enhancing the transglottal flow of air during the occlusion have been discussed, no attention having been paid to the role of the vocal folds themselves. For example, Chomsky and Halle (1968: 301) have argued, on purely theoretical grounds, that voicing in obstruents involves quite different adjustments of the vocal cords than does voicing in resonants. Referring to the theoretical investigations by Halle and Stevens (1967) they claim that in obstruents periodic vocal cord vibrations can be maintained only if the open phase during each glottal vibration is lengthened over that normally found in vowels and that "the increased glottal opening would also help to maintain the vibration in the face of the reduced pressure drop across the glottis resulting from the buildup of pressure behind the consonantal constriction in the supraglottal cavity" (Chomsky and Halle 1968: 301). As evidence they state "certain well-known observations", for example that the (transglottal?) air flow in voiced obstruents is noticeably faster than that in resonants.

The above theoretical argumentation, however, besides lacking experimental confirmation, is untenable also on theoretical grounds. How, in the presence of the aerodynamic constraints discussed above, could a larger open phase of the glottal vibrations and the resulting faster transglottal air flow help to prolong voicing during stop occlusion? One would rather wish to postulate a shorter open phase and slower transglottal flow to delay the equalization of the transglottal pressure drop. As for experimental data Ladefoged (1973: 78-79), on the basis of his own quantitative data on the relation between subglottal pressure, airflow, and frequency of vibration of the vocal cords (Ladefoged 1967), claims that there is in fact a decrease in transglottal flow in voiced obstruents. Moreover, he claims that the lowering of pitch observed during and after voiced stops (see e.g. House and Fairbanks 1953) is sufficiently accounted for by this decrease

in transglottal flow, without a need to presume any adjustments of the positions of the laryngeal structures. On the other hand, Stevens (1977: 270-272) argues that larynx lowering and raising in voiced and voiceless stops, respectively, are mere concomitants of the more primary gestures of vocal cord slackening and stiffening. However, as admitted by Stevens (p. 278), the feature system containing, among other features, vocal cord slackening and stiffening is only speculative in nature.

In sum, then, we conclude that, to the best of our knowledge, the mechanisms facilitating the prolongation of the transglottal pressure difference through an expansion of the oropharyngeal cavity seem to be the - both theoretically and experimentally - best motivated explanations for the occurrence of voicing during stop occlusion. In addition, adjustments of the vocal cords themselves may have an effect. Experimental evidence for such adjustments is not available, however, and theoretical considerations do not suggest them either, given the sufficiency of the aerodynamic measures.

### 2.2. Voiceless Aspirated Stops

Aspiration is the voiceless interval from the release of a voiceless stop to the onset of voicing during the following vowel or resonant (preaspiration being the interval from the offset of voicing in the preceding vowel or resonant to the implosion of a stop; this rather special case will not be discussed below). Acoustically, the release of aspirated stops usually consists of a short period of strong turbulent noise similar to the homorganic fricative, followed by [h] -like frictional noise of less intensity and containing spectral information about the transition of the articulatory configuration appropriate for the occlusion toward that appropriate for the next articulatory target. Although it may be difficult, in an acoustic

analysis, to segment the whole of the release into these components they should, nevertheless, be regarded as separate phenomena on the basis of their (at least semi-) independent controllability. The homorganic fricative noise is generated at the place of the occlusion and its strength and duration are, roughly, the function of the intraoral pressure at the moment of release and the rate at which the constrictory articulators move apart after the release, respectively. The higher the intraoral pressure at the critical moment, the stronger the homorganic fricative noise, ceteris paribus. Similarly, the slower the movement apart of the constrictory articulators, the longer the duration of this noise. In affricates, of course, the fricative-like constriction following the release is maintained much longer than in stops and may, indeed, be as long as the whole aspiration of a heavily aspirated stop. The [h] -like frictional noise following the explosive burst, on the other hand, is generated at the glottis and its duration is a function of the time taken for the glottis to return, from an open position at the release, to the position appropriate for voicing (see below). Thus, as the existence of affricates (or affricated stops) and aspirated stops indicates, the articulatory mechanism offers possibilities for an independent control of the durations of the homorganic explosive noise and of aspiration. Yet, as we shall see in discussing the English stops in more detail, the former can be highly dependent on the mechanisms responsible for aspiration.

Another question is whether, perceptually, it is the lack of voicing during the release or the presence of the concomitant noises that is the more important acoustic cue for the identification of an aspirated stop. The relative strengths of these cues can only be assessed through perceptual experiments involving synthetic or distorted speech: in normal speech production the cues cannot be independently controlled.

The physiological mechanisms underlying aspiration are well documented: aspiration is effected by a glottal abduction gesture, causing the glottis to be open at the time of the release of the oral closure. Lisker et al. (1969) and Sawashima et al. (1970) have found out, using transillumination of the larynx in running speech by a fiberoptics system, that the opening of the glottis characterizing aspiration in English is effected by controlling the arytenoid cartilages which are responsible for the opening and closing movements of the glottis. Similar observations about voiceless, aspirated stops have been made in a number of languages, see e.g. Frøkjaer-Jensen et al. (1973) for Danish; Sawashima and Miyazaki (1973), Sawashima and Niimi (1974), Hirose and Ushijima (1978) for Japanese; Kim (1970), Kagaya (1971), Abberton (1972), Hirose et al. (1974) for Korean; and Lindqvist (1972) and Löfqvist (1975) for Swedish.

According to Kim (1970), the duration of aspiration is a function of the size of the glottal opening at the time of the release of the oral closure: the wider the glottis at the release, the longer the aspiration. More specifically, Kim's view (p. 112) is that the instructions to close the glottis (towards the position appropriate for voicing) after the release are simultaneous (relative to the moment of release) for all voiceless aspirated stops regardless of the differences in the durations of their aspiration, these different durations being the result of differences in the size of the glottal opening at the moment of release. Lisker and Abramson (e.g. 1971), on the other hand, maintain that the timing of the instructions to close the glottis is responsible for the differences in the duration of aspiration, emphasizing thus the importance of the timing difference as an independent physiological mechanism.

Confirmation of Lisker and Abramson's view comes from the electromyographic (EMG) studies of the intrinsic laryngeal muscles in voicing control conducted by Hirose and

Gay (1972). They studied the EMG activity of a number of these muscles in the speech of two American English speakers and observed that the posterior cricoarytenoid (PCA) muscle, an abductor causing the arytenoid cartilages (and consequently the vocal folds) to be separated, actively participates in laryngeal adjustments, particularly for the /ptk/-/bdg/ distinction (for similar results in Japanese see Hirose and Ushijima 1968). There was a consistent increase in PCA activity for /ptk/ regardless of phoneme environment, and no such activity for /bdg/. In sum, the authors state that their data "would suggest the ubiquity of an independent timing control mechanism" (p. 161). To this may be added that the existence of preaspirated stops also gives strong support for possibilities to control the relative timing of glottal and supraglottal articulations (preaspirated stops involving a glottal abduction gesture in advance of the beginning of the oral constriction).

As a result of the glottal abduction gesture vocal fold vibration is inhibited until the glottis again returns to the adducted position. The voicelessness of the occlusion is thus extended over to the next segment.

3. Physiological Correlates

There is great variation in the acoustic manifestations of the English /ptk/-/bdg/ distinction in different environments. One aim of the physiological investigations has been an attempt to find, at some level of speech production prior to the acoustic one, context-independent, invariant correlates of the linguistic opposition in question. The context-dependent acoustic output variations in the realizations of this distinction could then be explained to result from automatic, universal peripheral constraints, anatomical, inertial, aerodynamic or otherwise. The use of such pairs of terms as "voiceless"-"voiced", "fortis"-"lenis", or "tense"-"lax" often implies

an acknowledgement of the existence of such a level. The discovery of such a level must await future research; in the meantime, we shall see that some of the suggested terms seem, in the light of the experimental evidence available today, more felicitous than some others. Next, data on the most important physiological parameters of the English /ptk/-bdg/ distinction will be surveyed.

### 3.1. Subglottal Air Pressure

The feature 'heightened subglottal pressure' was invoked by Chomsky and Halle (1968: 326) to explain the aspiration in /ptk/. The relevant parts of their feature system have been extensively criticised elsewhere (see e.g. Lisker and Abramson 1971, Ladefoged 1973); here it is sufficient to point out that experimental investigations have failed to assess significant differences in subglottal pressure in the production of /ptk/ and /bdg/ in English. Thus Netsell (1969), for example, using three speakers of American English as subjects, made simultaneous recordings of subglottal and supraglottal air pressures and came to the conclusion that the respiratory system generates an essentially invariant driving pressure with regard to the /ptk/-/bdg/ distinction. Similar results have been obtained by Ladefoged (1967: 41-44), Lieberman (1967: 97) and Shipp (1973). Thus we can conclude that the lungs do not actively participate in the distinction.

### 3.2. Supraglottal (intraoral) Air Pressure

Peak intraoral air pressure measurements generally show higher values for members of the set /ptk/ than for /bdg/ (Malécot 1966a, Arkebauer et al. 1967; Netsell 1969; Lubker and Parris 1970; Tatham and Morton 1973; Warren and Hall 1973; Shipp 1973). However, the peak pressures

reached in the two sets are often similar, and what really distinguishes them is that in /ptk/ the intraoral pressure reaches its maximum (i.e. the level of the subglottal pressure) almost immediately after the beginning of the occlusion, while in /bdg/ there is a gradual increase with the maximum pressure occurring at the end of the occlusion and often not reaching the level of the subglottal pressure (see especially Lisker 1970 and Shipp 1973). The explanation for this difference is in the activity of the glottis: in /ptk/ the glottis, as a result of the abduction gesture, is wide open soon after the implosion, enabling the almost instantaneous equalization of the subglottal and intraoral pressures, whereas in /bdg/ the glottis acts as a kind of valve, letting only small quantities of air at a time to escape through the larynx. Moreover, the task of the active mechanisms of oropharyngeal cavity expansion discussed above is to delay the equalization of the transglottal pressure drop.

Thus, although a reliable index of the /ptk/-/bdg/ distinction, the intraoral air pressure is not an independent parameter nor does it reflect differences in subglottal air pressure. Differences in intraoral air pressure are simply caused by differences in the valvular activity of the glottis, they are concomitants of glottal adjustments effected by the intrinsic laryngeal muscles.

### 3.3. Muscular Tension

Malécot (1966b) studied the mechanical pressures exerted during stop occlusion in American English. According to his measurements there are no significant differences between the two sets of stops in this respect. Kent and Moll (1969: 1555) conclude that homorganic stop and nasal consonants are produced with a common gesture of the constrictory articulator. Similarly, according to Lubker and Parris (1970: 625) who measured intraoral air pressure,

force of labial contact and labial EMG activity in /p/ and /b/, the labial gesture for the two stops is essentially monotypic, requiring no more forceful labial contact for one than for the other. Further EMG studies by Harris et al. (1965), Fromkin (1966) and Tatham and Morton (1969) indicate no consistent difference in EMG peak activity between /p/ and /b/. The simultaneous recordings of upper lip, lower lip and jaw movements concomitant with intramuscular EMG during /p/, /b/ and /m/ by Sussman et al. (1973) indicate that, depending on context and the particular articulator displacement or velocity parameter or muscle activity investigated, any of the three consonants can involve the greatest displacement, the greatest velocity or have the highest level of EMG activity. Thus, although in the preparatory activity in anticipation of the stop closure /p/ had the fastest jaw elevation speed, the greatest amount of upper lip lowering and the fastest upper lip lowering as a result of complementary contribution of aerodynamic and neuromuscular forces, /p/ showed, on the explosion side of the stop, "the slowest mean lower lip depression speeds, the slowest jaw depression speeds across all vowel contexts, the slowest net jaw + lower lip depression velocity, and the smallest jaw and lower lip displacement following the release. The voiced stop /b/ was faster than /p/, but slower than /m/ in all these measures. However, the upper lip does not follow this hierarchy and, in fact, is opposite, with the net effect being the cancellation or minimization of any differences between the postocclusion maneuvres for the three stop cognates" (p. 416). However, the authors state (p. 415) that "where meaningful phonetic comparisons could be made, we often found small differences between the three stops /p/, /b/, and /m/ in terms of these three form of data [articulatory displacement, articulator velocity, and averaged EMG activity, K.S.]. We have made some statistical analyses of these differences, and though many of the differences are not statistically significant, the trends are

often consistent across the three dependent variables and subjects", and further (p. 402) that "we found that in terms of which muscles were operating and the approximate timing of their operation, the three bilabial consonants were basically equivalent".

We have already touched upon the features 'tense' and 'lax' in connection with mechanisms of oropharyngeal cavity expansion. If 'tenseness' is interpreted to involve activity of the pharyngeal musculature we should rather have to label /bdg/ 'tense' as they and not /ptk/ were seen to involve such activity. In fact Malécot (1970) claims that the /ptk/-/bdg/ (or 'fortis'-'lenis') distinction has little or nothing to do with articulatory energy but is a synesthetic interpretation by native speakers of the intraoral air pressure differences accompanying these two sets.

On the basis of the above discussion we venture the following conclusion: due to the variable aerodynamic conditions prevailing in the mouth as a result of different glottal adjustments in /ptk/ as against /bdg/ there are some minor differences between the two sets in the organization of the supraglottal constrictory articulations, but by and large the supraglottal constrictory gestures are similar for the cognate pairs and the existing evidence overwhelmingly points towards a different source for the /ptk/-/bdg/ distinction, the features 'tense'-'lax' thus lacking experimental confirmation as characterizers of the English stops.

### 3.4. Laryngeal Mechanisms

The aspiration characterizing the English /ptk/ is effected by a glottal abduction gesture (for data see section 2.2. above), causing an active devoicing of the occlusion and part of the following vowel. The maintenance of a sufficient pressure drop across the glottis requisite

for sustained phonation in /bdg/, on the other hand, is effected by an enlargement of the oropharyngeal cavity (for data see section 2.1. above). The oropharyngeal cavity expansion takes place as a result of pharyngeal cavity expansion or larynx lowering, or a combination of these. The interrelations between the muscles controlling these two types of expansion are not well known; Kent and Moll (1969: 1554) suggest that the hyoid bone depression and the co-occurring larynx lowering observed in /bdg/ are effected by an activation of the extrinsic musculature of the larynx and that this depression usually co-occurs with pharyngeal expansion which is caused, at least in part, by the constrictor muscles of the pharyngeal walls (Bell-Berti 1975).

In sum, then, we can conclude that the mechanism responsible for aspiration and for an active devoicing of the occlusion in /ptk/ is located in the glottis, in the activity of the intrinsic laryngeal musculature. The oropharyngeal cavity expansion operating in /bdg/ is controlled by the extrinsic laryngeal muscles or by the muscles of the pharyngeal walls, or both.

### 3.5. Durational Differences in the Supraglottal Articulations

In this section parameters of two types will be discussed, viz. the duration of the occlusion in the two sets of stops and the influence of the /ptk/-bdg/ distinction on the duration of the adjacent vowels.

On the whole, rather little information is available about the relevant durational patterns, especially with regard to the duration of the occlusion in the non-medial positions and with regard to the effect on the adjacent segments in the word initial and medial positions. Moreover, the data obtained for these positions are often conflicting. As for the word initial position, Lisker (1972)

concludes that "it appears that a difference in closure duration is far from being a regular feature of the contrast between English /ptk/ and /bdg/" (p. 342). However, this conclusion is based on the measurement of the productions of a single speaker only. Mutanen (1973: 41) reports an equal duration of the occlusion for the labial cognates but shorter durations for /tk/ than for /dg/.

In an assessment of the possible effect of the word initial /ptk/-/bdg/ distinction on the duration of the following vowel the placement of the boundary between the stop and the vowel is of crucial importance since the inclusion of the release phenomena in either the stop or the vowel makes a big difference. Thus Peterson and Lehiste (1960), for example, conclude that the average duration of a syllable nucleus was shorter after a voiceless consonant than after a voiced consonant if aspiration was excluded from this measure. If, on the other hand, aspiration was considered part of the syllable nucleus the latter was longer after a voiceless consonant. In conclusion, the authors state that the influence of an initial consonant on the duration of the (following) syllable nucleus followed no simple regular pattern. Although the segmentation conventions followed in Suomi (1976) were somewhat inconsistent in this respect the same conclusions can, after some computation, be made on the basis of the results obtained (pp. 20-22). That is, disregarding differences due to /place of production/, vowels following /ptk/ were longer if aspiration was considered part of the vowel and, if aspiration was excluded, no consistent differences between the two sets could be observed.

The results obtained for the medial position are similarly controversial. Thus Gimson (1970: 154), for example, on the basis of an explicit reference to Lisker's (1957) measurements, maintains that the closure duration is longer medially in /ptk/ than in /bdg/. However, a closer examination of Lisker's paper reveals that the

closure duration of the labial cognate pair was found to be different only when preceded by a stressed syllabic and followed by an unstressed one, there being no significant differences under the other conditions. Similar results were later obtained by Lisker (1972) on the basis of intraoral pressure recordings although, again, in the speech of a single informant.

Kent and Moll (1969) found no differences in the durations of the articulatory closures of the cognate pairs in a VCV frame where equal stress was to be placed on both of the syllables. Lubker and Parris (1970), on the other hand, found out that, depending on the placement of stress in the utterance, either /p/ or /b/ had a longer duration of labial contact. The differences between the cognates in each particular utterance type were, however, at most 12 msec. Thus, while the duration of the occlusion was greatly affected by variations in the placement of stress, both cognates seemed, by and large, to follow similar patterns. Similarly, the results obtained in Suomi (1976: 28-37) indicate no consistent differences in the duration of the occlusion (as assessed by acoustic measurements) between cognate pairs (that is, although significant differences were obtained between /p/, /k/ and /b/, /g/, respectively, the differences in mean durations were negligible and there was, moreover, an opposite trend with regard to /t/ and /d/).

The conclusion to be drawn from the above discussion is, then, that although the duration of the occlusion of word medial stops is greatly influenced by e.g. stress the two sets are similarly affected. The majority of the available data suggests that the intercognate differences are at most unsystematic and small. This suggests that the duration of the occlusion of word medial stops cannot be effectively used as a cue for the /ptk/-/bdg/ distinction although investigations examining these sounds in as many different environments as possible are clearly needed.

Experimental data on the effect of the word medial /ptk/-/bdg/ distinction on the duration of the preceding vowel are hard to find. A careful inspection of the "classical" literature on vowel duration revealed that the vowels examined preceded word final consonants in mono- or disyllabic words (e.g. Belasco 1953, House and Fairbanks 1953, Zimmerman and Sapon 1958, Peterson and Lehiste 1960, House 1961) and the data, therefore, are not relevant here. The only data from this period that are directly relevant to the present discussion are those by Sharf (1962) who has measured the duration of vowels preceding word medial consonants. According to Sharf (p. 29) the duration ratio of vowels preceding word medial /p/ and /b/ is about 3:4 and that of vowels preceding /k/ and /g/ about 4:5 (the single speaker used as an informant used an alveolar flap for both /t/ and /d/ and, consequently, no corresponding differences in these stops could be detected). However, the results obtained must be viewed with some scepticism. The measurements are based on a single speaker; the number of occurrencies of the different structures is not given; the segmentation conventions are not stated; and the words were recorded directly on to the tape-loop of a spectrograph (with little possibilities of checking the naturalness of the recordings afterwards). Wiik's (1965: 114-117) data refer to vowels before word final consonants in monosyllables. Small but unsystematic differences in vowel duration before word medial /ptk/ and /bdg/, respectively, were obtained in Suomi (1976: 28-37) on the basis of acoustic measurements. The results indicate a slight reciprocal tendency between the durations of the occlusion of the medial stops and the durations of the preceding vowels: in the case of labial and velar stops the /voiceless/ cognate exhibited a longer closure duration and a shorter duration of the preceding vowel but in the alveolar stops there was no difference in occlusion duration and the preceding vowel showed an inverted pattern compared

to the other places of production. On the whole, the obtained differences were negligible and could be the result of a systematic error in segmentation in the two sets of stops. Scully (1974) has pointed out that the duration of an articulatory occlusion cannot be directly inferred from the duration of the resultant acoustic occlusive segment, and this may have biassed the results somewhat.

As for the influence of the word medial /ptk/-/bdg/ distinction on the duration of the following vowel, no data whatsoever could be found.

We must draw the conclusion, then, that durational differences in the supraglottal articulations do not seem to differentiate word medial, intervocalic /ptk/ from /bdg/.

Again it was difficult to find data on the duration of the occlusion of word final /ptk/ and /bdg/. Suen and Beddoes (1974) obtained longer closure durations for /ptk/ than for /bdg/, the average difference between the two sets being of the order of 33 msec. The measurements of Suomi (1976: 48-53) indicate a statistically strongly significant difference between the two sets to the effect that /ptk/ had a longer closure duration, the differences between the cognate pairs being 20 to 30 msec. Similar differences between word final /p/ and /b/ were obtained by Lubker and Parris (1970: 631) on the basis of intraoral pressure recordings, both after stressed and unstressed vowels. The limited but parallel information available suggests, then, that in this position, in contradistinction to the others, a regular difference in the duration of the occlusion accompanies the /ptk/-/bdg/ distinction.

That vowels and resonants have a longer duration before word final /voiced/ obstruents than before /voiceless/ ones in English is such an established piece of knowledge that there is no need to repeat the mass of references to published data here. Similar observations have

been made with regard to a number of languages, and it is possible that part of the durational variation is controlled by some kind of a universal articulatory constraint (see, for example, Zimmerman and Sapon (1958) for Spanish, Fintoft (1962) for Norwegian, Wiik (1965) for Finnish (in Wiik's /voiced/ category only one obstruent is included, viz. /d/), and Chen (1970) for French, Russian and Korean). The prolongation of vowels and resonants before a word final obstruent is, however, much more drastic in English than in the other languages, and no doubt the extra lengthening is a language specific feature of English (see especially Chen 1970).

Chomsky and Halle (1968: 301) have argued that the lengthening before /voiced/ obstruents is caused by the extra time needed by the glottis to shift from the configuration appropriate for vowels to that appropriate for obstruents. However, no evidence for such glottal readjustments for /bdg/ is available. On the contrary, the results obtained by Raphael (1975) seem to indicate that the durational variations are primarily controlled physiologically by motor commands to the muscles governing the articulators that are active in the formation of vowels. From a purely functional perspective it could be argued that, given the often voiceless occlusion of word final /bdg/, the duration of the preceding vowel has assumed (part of) the function to signal the word final consonant distinction. This contention is supported for example by Raphael's conclusion (1972), based on a perceptual investigation, that the duration of the preceding vowel is a sufficient (and for the types of stimuli used in his experiments, a necessary) cue to the perception of the /voiceless/-/voiced/ character of a word final stop, fricative or consonant cluster. Raphael further concludes that the presence of voicing during the closure period does have some cue value, although it is minor compared to that of the preceding vowel duration.

4. A Summary of the Phonetic Correlates

In this section an attempt will be made to relate to each other the various phonetic parameters discussed above. This will take place in terms of the three positions already referred to, viz. the word initial, medial and final positions, and the references to relevant data can be found in the appropriate places above.

Regardless of position, subglottal air pressure does not vary as a function of the /ptk/-/bdg/ distinction. In a similar way, the available data do not indicate, in any meaningful way, systematic differences in muscular tension or in the muscular energy expended. How, for example, could we compare the energies needed to abduct the glottis in /ptk/ on the one hand and to enlarge the oropharyngeal cavity in /bdg/ on the other hand?

Let us discuss the word initial and medial positions first. In /ptk/ there is a glottal abduction gesture causing the vocal cords to be wide apart at and after the release of the oral constriction. This physiological mechanism has several concomitant phonetic consequences. First of all, it causes a virtual equalization of subglottal and intraoral air pressures at an early stage of the occlusion, evidenced by the high intraoral pressure values reported for these stops. Immediately after the release, the glottis is still open, allowing air of high pressure to escape not only from the oropharyngeal cavity between the glottis and the constriction but from the subglottal cavities of much larger volume as well. This explains the strong explosive burst, with homorganic friction, characterizing these stops. At the same time, the return of the glottis from the open position to that appropriate for voicing causes a delay in the onset of voicing for the following vowel or resonant. The duration of the resultant aspiration depends on the time taken by the glottis to perform this maneuver.

It is a common observation that the duration of aspiration varies also as a function of the place of production of the stops so that, usually, labial stops have the shortest and alveolar or velar stops the longest aspiration. It would seem counter-intuitive to assume that these differences originate in the glottis itself, and in fact there are indications that the differences are the result of an interplay between invariant glottal activity and variable supraglottal articulations. In Suomi (1976: 37-43) it was observed, for example, that there was a compensatory relationship between the durations of the occlusion and the duration of aspiration in word medial /ptk/. These results (based on a mingographic analysis) were interpreted (pp. 62-64) to show that by postulating a unimodal glottal abduction gesture for the whole set the observed differences in the duration of aspiration could be explained by the differences in the durations of the supraglottal occlusions alone, the total durations (occlusion + aspiration) being the same for each place of production. More direct information of a similar pattern was obtained and similar conclusions were drawn for Swedish aspirated stops under various conditions by Löfqvist (1976).

In the two positions mentioned above /bdg/ are characterized by a glottal configuration similar to that found during vowels and resonants, i.e. the vocal cords are in the position appropriate for voicing. The aerodynamic consequence is that, whether there is actual vocal cord vibration or not, the passage across the glottis is relatively obstructed, preventing the instantaneous equalization of subglottal and supraglottal (intraoral) air pressures during the occlusion found in stops with a glottal abduction gesture. Whether, at the end of the occlusion, the intraoral pressure reaches the level of the subglottal one or not (and it must not, if voicing is to be maintained throughout the occlusion), the glottis is

still relatively narrow at the moment of the release of the oral constriction, holding back the air contained in the lungs, and the explosion burst is necessarily weaker in these stops than in aspirated ones, ceteris paribus. At the same time, the state of the glottis at the release enables an immediate application of the Bernoulli effect, without any appreciable lag in the onset of voicing for the following voiced sound or, indeed, without any break in the glottal vibrations in the case of fully voiced stops.

The extent of voicing during the occlusion depends mainly on the effectiveness of the use of the mechanisms facilitating the transglottal flow of air through an expansion of the oropharyngeal cavity at the expense of the subglottal ones (which, in this context, can be regarded as a single cavity). It seems that in English, as already discussed, relatively little use is made of these mechanisms in the word initial and final positions, at least in citation forms. In word medial /bdg/ the occlusion is usually fully voiced in all kinds of speech. Now there are at least two possible explanations for this discrepancy with regard to voicing in the three positions. On the one hand, it could be the case that because in isolated words (citation forms) higher-order grammatical boundaries co-occur with word boundaries the frequent complete voicelessness of the occlusion of /bdg/ in these positions could be caused by allophonic devoicing rules sensitive to such grammatical factors. The occurrence of full voicing in word medial /bdg/ could then be explained as a result of the lack of such boundaries in the neighbourhood. On the other hand, it could be argued that the weakly voiced word initial and final /bdg/ represent more closely the canonical or target forms of these stops and that the full voicing of /bdg/ word medially is caused by the proximity of naturally voiced sounds (ideally when the stop is between vowels). In this case we would be dealing with (an at least theoretically simple case of)

partial assimilation. This assimilatory force could also conceivably be used as an explanation for the frequent occurrence of completely voiced occlusions in word initial and final /bdg/ in rapid connected speech. The crucial point, then, is whether the English /bdg/ are, in comparison to the equivalent stops of, say, the Romance or Slavic languages, inherently less voiced or whether the various grammatical junctures have a stronger tendency to devoice /bdg/ in English. Considerations of the phonetic manifestations of both sets /ptk/ and /bdg/ in the languages in question, and especially their distribution on the voicing continuum, would seem to favour the solution postulating differences in the inherent degree of voicing, in the canonical or target values of these stops. However, without extensive cross-language studies we are in no position to answer this question.

It seems, then, that in the word initial and medial positions the phonetic differences accompanying the /ptk/-/bdg/ distinction can, by and large, be accounted for by the differences in the glottal behaviour alone.

The word final position is unique for at least two reasons. Firstly, the glottal mechanisms responsible for differentiating the two sets in the other positions cannot be effectively used since, in utterance final position at least, the timing of the voice onset for the following vowel or resonant is necessarily inapplicable. One of the acoustic concomitants of the difference in glottal behaviour, the strength of the explosive burst can, admittedly, operate also here, but the use of this cue is somewhat marginal since the English stops are often not released audibly in this position. To this may be added that the extent of voicing of the occlusion is also a weak cue as even the occlusion of /bdg/ is often completely voiceless. Secondly, the final position seems to be the only one in which large and systematic differences in the supraglottal articulations accompany the distinction, vowels having a

longer duration before /bdg/ and the closure duration being longer in /ptk/. It is these durational differences that are the strongest acoustic exponents of the distinction in this position. Thus we cannot generalize by stating that ultimately all the acoustic manifestations of the /ptk/-/bdg/ distinction in the three major positions can be traced back to a rather simple difference in glottal behaviour in the two sets since the differences in the supraglottal constrictory articulations in the word final position cannot conceivably be attributed to direct glottal control. Yet it is part of the native speakers' intuition that /bdg/ remain "the same" and distinct from /ptk/, irrespective of their position in the word or larger entities. Similarly, it is part of the task of linguists to try and capture this intuition in their descriptions. Next, an attempt will be made to define the common denominator uniting the phonetic manifestations of the /ptk/-/bdg/ distinction in English in the three positions.

## 5. An Interpretation

Let us assume that, at some unspecified level of the phonology of English, the decisive difference between /ptk/ and /bdg/ consists of the former being associated with less voicing or glottal vibrations than the latter, either before, during or after the supraglottal constrictory articulation. The phonetic manifestations of this difference can be described in terms of such parameters as voice offset time and voice onset time relative to the occlusion, with their concomitant differences in the extent of voicing during the occlusion, the strength of the explosive burst, the duration of the aspiration etc. Without repeating ourselves too much we can maintain that, ceteris paribus, word initial and medial /bdg/ are always characterized by more glottal vibrations in the neighbourhood of the occlusion than /ptk/, no matter what other differences may be detected. More specifically, it

is the relative amount of voicing during and after the occlusion that is important in these positions.

In the word final stops, however, the same parameters cannot be effectively used because the occlusion is (often) voiceless in both sets and the acoustic manifestations of the differences in glottal behaviour (strength of the burst, aspiration) can be of marginal importance. The prolongation of the vowel before /bdg/ and the lengthening of the occlusion in /ptk/ can now be interpreted to be a means of securing the conformity of the word final position to the general principle, the former actually increasing the number of glottal vibrations and the latter acting as a reinforcement through a change in the vowel/consonant ratio. Thus, given the inapplicability of the more usual cues and the resultant danger of a neutralization of a linguistic opposition, the two measures can be claimed to form, although on a rather abstract level, a conspiracy (Kisseberth 1970) with the purpose of preserving the opposition. Despite the terminology used it is not here claimed that a speaker of English acts according to the above considerations; rather, the discussion is meant to provide some possible reasons for the historical sound changes that have lead to the present situation. In a formal synchronic description it could be postulated that the rules responsible for decreasing the differences between the two sets (e.g. the rule devoicing the occlusion in /bdg/) precede the vowel and consonant lengthening rules, creating a situation where a neutralization might arise although later rules (e.g. allegro rules, see Dressler 1975) may again voice /bdg/ and, more generally, make the application of the usual glottal mechanisms possible.

If the somewhat abstract argumentation above is accepted, the following generalization can be stated: in English /ptk/ are, ceteris paribus, associated with fewer glottal pulses than /bdg/, counted forward (or "left-to-right") from the beginning of the occlusion if a syllable

follows in the same word, and backwards ("right-to-left") if not. This algorithm is, of course, directly applicable on the acoustic level, and the concomitant differences can be disregarded (in the rarely occurring situation where we have to decide which of two otherwise identical utterances contains which cognate).

## 6. Terminological Considerations: How to Label the Distinction?

From a purely formal point of view the choice of a name for the classificatory feature distinguishing, inter alia, /ptk/ from /bdg/ is a matter of little importance as long as the feature is consistently used. If, on the other hand, it is considered desirable (as I do) that our phonological descriptions be as firmly anchored in the phonetic foundations as possible, it could be maintained that the labels of the distinctive features should, as far as possible, reflect the real processes responsible for the conveyance of the distinction in speech. The observation of the substantive content of distinctive features is also, as far as I see, one of the cornerstones of the theory of markedness (in the sense of e.g. Chomsky and Halle 1968). Moreover, cross-language comparisons (historical, typological, pedagogical etc.) presuppose an objective frame of reference, which is easily obscured if too abstract labels are ineptly used. It may be impossible to find a perfectly telling and exhaustive label for a given distinction but there is, I think, a difference between clearly counterfactual labels and ones that capture some aspect(s) of the phonetic exponents of the distinction. Thus, there seems to be some objective motivation for an evaluation of the appropriateness of particular labels. If the demands suggested above for distinctive features are accepted, it follows that a certain group of labels must be rejected, namely those that are false, too

abstract or too vaguely defined to be subjected to empirical verification.

The labels suggested for the English /ptk/-/bdg/ distinction include "tense"-"lax", "fortis"-"lenis", "aspirated"-"unaspirated", "± heightened subglottal pressure", "voiceless"-"voiced", and their various paraphrases. Let us consider each of these dichotomies in terms of the appropriateness defined above.

The data surveyed in section 3.3. above indicate that the labels "tense"-"lax" are inappropriate because they lack experimental validation; the various more or less heuristically selected parameters, intended to capture the correlates of this distinction, were seen to exhibit no systematic differences between the two sets. The Chomsky and Halle (1968) feature "± heightened subglottal pressure" was seen to be proven counterfactual (see section 3.1.) and must be rejected. The terms "fortis"-"lenis", which are defined by Gimson (1970: 151) as involving different amounts of muscular energy and different degrees of breath effort, are likewise not supported by the experimental data available. If "muscular energy" here refers to the total energy expended in the production of the two sets of stops the claim must be considered premature since, at present, it is not possible to measure that energy. "Breath effort" can have two interpretations: if it refers to differences in subglottal air pressure the claim is counterfactual; and if it refers to differences in intraoral air pressure the term is superfluous since the differences are not an independent variable but an automatic consequence of other, mainly glottal, adjustments. The terms "aspirated"-"unaspirated", although consistent with the facts in certain positions, must be considered inadequate because of their inability to characterize the two sets in all positions.

The remaining terms, "voiceless"-"voiced", are often criticized on the grounds that the absence vs. presence

of glottal vibrations during the occlusion characterizes the distinction only in certain environments (e.g. word medially between vowels) while in the word initial position, for example, the distinction is signalled by the presence vs. absence of aspiration, while both sets are in fact voiceless, etc. However, leaving the word final position aside for a moment, it can be claimed that this kind of argumentation is basically the result of viewing speech as a sequence of static segments, segments that either possess or do not possess a certain property, e.g. voice. On the preceding pages, however, I have attempted to show that a single mechanism, the timing of the offset and onset of glottal vibrations relative to the supraglottal constrictory articulations is responsible for the seemingly disconnected peripheral acoustic variation accompanying the /ptk/-/bdg/ distinction (this is, of course, what Abramson and Lisker have been maintaining for a long time in their writings). Due to the nature of things, the voicing continuum, ranging from full voicing to maximal voicelessness in the form of extensive aspiration, involves qualitatively discontinuous changes in the acoustic output. Thus, given the subglottal air pressure and the supraglottal articulations as constants, the timing of the offset and onset of voicing (by the proper use of oropharyngeal cavity expansion or the glottal abduction gesture) relative to the supraglottal articulations will create most of the peripheral acoustic variations quite automatically. From the point of view of the acoustic output the crucial question is whether or not the vocal folds are ready to start vibrating immediately after the release. Thus, a consideration of the voice controlling mechanism together with the introduction of the time dimension into the description brings order into an apparent chaos.

Another argument sometimes put forth against differences in voicing as a systematic index of the /ptk/-/bdg/

distinction is the fact that in whispered speech all segments are voiceless and yet the distinction can be maintained. However, this is a special case comparable, for example, to the neutralization of tonal distinctions in singing, and it cannot be used to falsify claims about the nature of normal, phonated speech. Anyway, it seems likely that the noise concomitants of the glottal adjustments take on a special importance in whispered speech, /ptk/ being differentiated from /bdg/ on the basis of the stronger noises following the release in the word initial and medial positions, while the word final distinction is perhaps adequately manifested by the differences in the duration of the (voiceless) vowel preceding the silent occlusion, with the possible addition of noise differences if the stops are released in this positions.

It was seen above that in acoustic terms, too, the labels "voiceless" and "voiced" are to be regarded as the most appropriate ones among those mentioned since the number of glottal vibrations connected with /ptk/ and /bdg/ is the most objective and reliable single acoustic index of the distinction. What the terms cannot directly cover is the word final position, but if we accept the (admittedly somewhat stretched) definition presented at the end of section 5. to include this special case we have good grounds, I think, to designate /ptk/ and /bdg/ as /voiceless/ and /voiced/, respectively, until a more appropriate pair of labels is found. I want to finish this discussion by quoting Henderson who, in discussing the related issue of 'register' languages, says that "there is obviously great attraction in the theory of a single feature that could plausibly account for such diversity of associated phenomena, but in my view it is too early to think in terms of 'phonological features'. The last thing we need at the moment is a 'cover feature' to mask our ignorance of the physical parameters involved. As Henderson himself says:'from a phonemic point of view, any

set of terms may serve to designate that A ≠ B.' What is needed first is a thorough investigation - articulatory, acoustic and perceptual - into what is actually happening. Only when we are reasonably clear about that can we usefully set up 'phonological features' of some kind." (Henderson 1977: 258-259).

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# THE VOICELESS - VOICED OPPOSITION OF ENGLISH CONSONANTS: DIFFICULTIES OF PRONUNCIATION AND PERCEPTION IN COMMUNICATION BETWEEN NATIVE AND FINNISH SPEAKERS

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## 1. INTRODUCTION

### 1.1. Aspects of the English and Finnish Consonant Systems

The English consonants where sound pairs are distinguished by the so called voiceless – voiced distinction, can be described as follows:

| bilabials | labio-dentals | dentals | alveolars | palato-alveolars | velars | glottal | |
|---|---|---|---|---|---|---|---|
| p – b | | | t – d | | k – g | | stops |
| | f – v | θ – ð | s – z | ʃ – ʒ | | h | fricatives |
| | | | (tr – dr) | tʃ – dʒ | | | affricates |

The affricates /tr/ – /dr/ are bracketed because they are not unanimously considered as affricates, but as sequences of two sounds. However, Gimson (1966:168), for example, regards these as complex sound entities called affricates.

English has complete *voiceless – voiced*, or *fortis – lenis* pairs in the sound categories stop, fricative and affricate. Finnish, on the other hand, lacks such pairs almost completely. Only with the dental and alveolar stops could the other member of the pair be included in the paradigm, but even here only in brackets, because it can be maintained that the distinction between Finnish /t/ and /d/ is primarily a distinction of the place of articulation, and only secondarily of the presence or absence of voice. As for the bilabial and velar stops, Finnish has only /p/ and /k/, and lacks the voiced, or lenis, counterparts of the pairs. With fricatives, Finnish has only the alveolar /s/; the Finnish /v/ is regarded as a semivowel, not a fricative. English can present four fortis – lenis pairs of fricatives at different places of articulation.

Finally, English has a pair, or, according to some phoneticians, two pairs of affricate sounds, and this sound category does not exist in Finnish at all.

The distribution of the English consonants is very free: all the consonants mentioned above can occur in word initial, word medial and word final positions. On the other hand, the distribution of the Finnish consonant phonemes is very restricted: /d/, the only phoneme that can be distinguished from its counterpart through voice, is restricted to word medial position; /p/ and /k/ cannot occur in word final position; and there are strong restrictions in consonant clusters with regard to which consonants are allowed to follow each other.

From the above it can be concluded that the English consonant system is much more complicated than the Finnish one, and that the voiceless – voiced, or fortis – lenis distinction has a much stronger distinctive role in English than in Finnish.

1.2. General Considerations

When the observed differences between the English and Finnish consonant systems are taken into account, it can be predicted with certainty that Finnish-speaking people will meet many great difficulties in both producing and perceiving the English sounds correctly. The present study was initiated because of a need to make this prediction more precise; what are the factors connected with the fortis – lenis distinction that cause difficulties in communication between English and Finnish people?

When a Finnish-speaking person starts to learn the pronunciation of English consonants, he must learn both to produce completely new sounds (e.g. /tʃ/ and /dʒ/), and to make use of features that are distinctive in English but not in Finnish (e.g. voice in /p/ – /b/, /s/ – /z/). It is often said that learning new distinctions of old sounds is even more difficult than learning to produce completely new sounds (see e.g. Gleason 1961, 160-161). The fortis – lenis distinction is such a new distinction for the Finnish learner. What is the fortis – lenis distinction? The traditional term of the feature, voiceless – voiced distinction, of course brings vocal cord vibration to mind; the vocal cords vibrate during the lenis sounds (also called voiced sounds), but they do not vibrate during

the fortis sounds (also called voiceless sounds). It is a fact that no vocal cord vibration is usually observed during fortis sounds, but vocal cord vibration is not always present during lenis sounds. This has led some phoneticians to reject the traditional terms *voiceless* and *voiced* and to posit the terms *fortis* and *lenis* instead (see e.g. Gimson 1966, 32, Suomi 1976, 3-4). These terms lead us to think about the muscular energy or force of articulation but, again, no empirical evidence for greater muscular tension during the so-called fortis consonants can be found. The terms *voiceless* and *voiced*, or *fortis* and *lenis* are, however, only kinds of abstract denominations for all the parameters that distinguish the fortis and lenis consonants from each other in different contexts (see Lehtonen 1972, 33). The discovery of some of these parameters is one of the goals of this study; the writer will attempt to answer the following questions: what is most relevant to the production and perception of the fortis – lenis distinction in English, and how do Finnish students of English succeed in producing and perceiving this distinction? A brief account is given below on how the problem was defined and what restrictions were made for the study.

The following consonant pairs were included in the study: /p/ - /b/, /t/ - /d/, /k/ - /g/, /f/ - /v/, /s/ - /z/, /tʃ/ - /dʒ/ and /tr/ - /dr/. The consonants were investigated in word initial, word medial and word final positions, and the main part of the study is concentrated on the word final position. The study concentrates mainly on single consonants, consonant clusters being dealt with only in connection with the word final position. The sounds were investigated only in stressed syllables and sentence-stressed words. Here is a brief survey of the scope of the study:

1) what factors are responsible for bearing the fortis – lenis distinction in different contexts for a native English speaker?
2) how can a Finnish-speaking student of English perceive this distinction?
3) what factors are responsible for bearing the fortis – lenis distinction in a Finnish-speaking student's speech? Are they different from those of the native English speaker?
4) how can a native English speaker perceive the distinction as produced by a Finnish student of English?

So the starting point of the study is in fact a communicative situation where one of the speakers is Finnish and the other English, and the language is English. The final goal is to discover at least some of the articulatory and perceptual difficulties connected with the fortis – lenis distinction.

1.3. Terminological Considerations

Agreement has still not been reached on which terms would be best to describe the so called fortis – lenis distinction. From a strictly phonological point of view the selection of the name for the distinctive feature is not very important as long as the two sets are consistently kept separate by the feature. From a pedagogical point of view, however, it may be wise to choose some abstract name for such a feature; this may help to prevent the language learner from regarding a certain phonetic feature as solely responsible for carrying the feature (see Suomi 1976: 3). In the present study, therefore, the designations *fortis* and *lenis* will be used for consonants traditionally defined as *voiceless* and *voiced*, respectively.

Another terminological aspect must also be explained. In connection with vowels, the terms *tense* and *lax* will be used rather more loosely than usual. This method of treatment was decided upon for purely practical reasons. In this report, the term *tense* will include all English vowels traditionally defined as "long", and all diphthongs; the term *lax* will include all vowels traditionally defined as "short", including /æ/ and /e/. This decision is, of course, open to criticism, because it has already been shown that the lax vowels and /æ/ do not always behave in the same way (see e.g. Suomi 1976, 44).

1.4. Phonetic Analysis

1.4.1. Selection of Speakers for the Pronunciation Test

Two groups of informants were selected for the first part of the study, the phonetic analysis. The first group consisted of three native (British) speakers of English. In selecting the British informants, very strong dialectal features were avoided, and the speech of these informants can be regarded as fairly close to colloquial standard British English. This group will hereafter be referred to by the letter *E*.

The other group consisted of three students of English chosen on the following criteria: male, Finnish as mother tongue and the completion of the cum laude course in English philology. The Finnish group will be designated by the letter *S* (abbreviated from Students).

1.4.2. Selection and Reading of Test Material

In the phonetic analysis, the investigation was restricted to certain temporal relations obtaining in the fortis – lenis distinction, i.e. the phonetic measurements were only concerned with durations of phonetic segments.

It was decided that the test material should consist of different sound environments. So it was constituted of three kinds of elements: single words, word groups where the word investigated was in the middle, and whole sentences (see Appendix 1). All of these formed so-called minimal pairs, i.e. pairs of words or sentences differing in one phoneme only. The test material was planned in this way for two reasons: firstly, and mainly, to receive results from as many different environments as possible, and secondly, to discover how the parameters carrying the fortis – lenis distinction differ in single words, word groups and sentences. The number of sentences in the test material is quite large. This made it possible to investigate the fortis – lenis distinction in an environment as close as possible to natural speech.
The test words, word groups and sentences were written on cards so that there was one word, word group or sentence on each card. The material was read from these cards by the informants, and recorded in the studio of the Phonetic Laboratory of the University of Jyväskylä, using an AKG D-202 dynamic microphone and a Revox A 77 tape recorder. The recording speed was 19 cm per second.

1.4.3. Analysis Procedures

The test tapes were analysed by Frøkjær-Jensen's Trans-Pitchmeter and Intensity Meter to which a 3-channel ink-writer (Mingograph) was attached. With this apparatus three curves were obtained, namely the duplex-oscillogram, an intensity curve with high-pass filtering at 500 cps for recording the segmental differences of higher frequency, and another intensity curve with low-pass filtering at 500 cps, which clearly indicates the presence or absence of fundamental frequency. The paper speed

used in the Mingograph was 100 mm per second, thus giving 1 mm of Mingograph paper = 1/100 sec. Measurements were made to the nearest 0,5 mm, representing 5 msec on the time scale. A few samples were also analysed by a Kay Elemetrics 6061 B sound spectrograph.

1.4.4. Test Parameters

On the basis of the three curves described above, the following parameters expressing temporal relations between acoustic events were measured.

*Word initial consonants.* The release duration (RD) of stops and affricates, the friction duration (FD) of fricatives, and the extent of voicing (EV) of stops, affricates and fricatives. And finally, the duration of the stressed vowel (VD) in the categories *tense* and *lax + /æ/, /e/.*

*Word medial consonants.* The silent interval (SI) [1], the release duration (RD) and the total duration (TD) of stops and affricates, the friction duration (FD) of fricatives, and the extent of voicing (EV) in all the sound categories mentioned above. The duration of the preceding vowel (VD).

*Word final consonants.* The silent interval (SI) [1] of stops and affricates, the release duration (RD) of affricates, the friction duration (FD) of fricatives, the extent of voicing (EV) in the sound categories mentioned, the duration of the preceding vowel (VD) in the categories *tense* and *lax + /æ/, /e/,* and the duration of the consonant preceding a word final consonant (PCD).

1.4.5. Statistical Analysis

The results were analysed statistically in the following way. First, the arithmetical means ($\bar{X}$) and standard deviations (s) for the parameters in the different word positions were calculated for each group from the original data of each informant. This means that all between-subject differences have been neglected, and each group is treated as homogeneous.

There are differences in the overall rate of speech between speakers,

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[1] In connection with voiced lenis consonants the silent interval is replaced by closure duration (CD).

It was noticed in this study that the average rate of speech of the Finnish informants speaking English was somewhat slower than that of the English ones. These random variations would have drastic effects on the results of a study of temporal relations like the present one, if straightforward statistical comparisons *between* the groups were made. Consequently, the statistical comparisons have been made *within* each group, i.e. how the parameters affecting the fortis – lenis distinction have been realized within each group. Accordingly, the durational differences due to different linguistic categories which affect the fortis – lenis distinction in different positions, have been tested for statistical significance by the t-test of independent means within the two groups. The significance of the durational differences has been indicated in the following way:

\+ = almost significant (P<5%)
++ = significant (P<2%)
+++ = (p<1%)
++++ = (p<0,5%)
} strongly significant

## 2. RESULTS OF THE PHONETIC ANALYSIS

### 2.1. Presentation of Data

In the tables below, the results of the phonetic analysis have been pooled from the data received from single words, word groups and sentences, and different places of articulation. So different places of articulation are not treated separately, although in a later section a brief survey will be given of the realization of the fortis – lenis distinction in the three different environments.

The tables below present the arithmetical means ($\bar{X}$) of the test parameters for each group of informants, the standard deviation (s), the number of instances (N), the difference of the arithmetical means ($\bar{X}_f - \bar{X}_l$), and the statistical significance of the difference (p) as specified by the t-test.

### 2.2. Word Initial Position

Tables 1 - 2 present the data on the elements influenced by the word initial fortis – lenis distinction.

Tables 1 - 2. *Word initial consonants.* Parameters release duration (RD) of stops and affricates, friction duration (FD) of fricatives, the extent of voicing (EV) of stops, affricates and fricatives, and the duration of the stressed vowel (VD) in the categories /tense/ and /lax + æ, e/. Abbreviations: /affr/ = affricate, /fric/ = fricative, f = fortis, l = lenis.

Table 1. The English informants (Group E)

| | $\bar{X}_f$ | $s_f$ | $N_f$ | $\bar{X}_l$ | $s_l$ | $N_l$ | $\bar{X}_f - \bar{X}_l$ | p |
|---|---|---|---|---|---|---|---|---|
| RD /stop/ | 63 | data lost[1] | | 19 | data lost | | 44 | ++++ |
| EV /stop/ | 0 | – " – | | 98 | – " – | | -98 | ++++ |
| RD /affr/ | 107 | – " – | | 50 | – " – | | 57 | ++++ |
| EV /affr/ | 0 | – " – | | 77 | – " – | | -77 | ++++ |
| FD /fric/ | 166 | – " – | | 87 | – " – | | 79 | ++ |
| EV /fric/ | 0 | – " – | | 77 | – " – | | -77 | ++++ |
| VD /tense | 237 | 88 | 31 | 231 | 69 | 31 | 6 | non |
| VD /lax + æ, e/ | 88 | 35 | 16 | 96 | 30 | 16 | -8 | non |

Table 2. The Finnish informants (Group S)

| | $\bar{X}_f$ | $s_f$ | $N_f$ | $\bar{X}_l$ | $s_l$ | $N_l$ | $\bar{X}_f - \bar{X}_l$ | p |
|---|---|---|---|---|---|---|---|---|
| RD /stop/ | 84 | data lost[1] | | 8 | data lost | | 76 | ++++ |
| EV /stop/ | 18 | – " – | | 106 | – " – | | -88 | ++++ |
| RD /affr/ | 105 | – " – | | 70 | – " – | | 35 | ++ |
| EV /affr/ | 0 | – " – | | 49 | – " – | | -49 | ++++ |
| FD /fric/ | 157 | – " – | | 119 | – " – | | 35 | non |
| EV /fric/ | 0 | – " – | | 90 | – " – | | -90 | ++++ |
| VD /tense/ | 263 | 58 | 28 | 273 | 30 | 28 | -10 | non |
| VD /lax + æ, e/ | 120 | 18 | 12 | 99 | 18 | 12 | 21 | non |

[1] Due to an accident, the data on the standard deviations and some instances of the parameters release duration, friction duration and extent of voicing were lost and cannot be presented here.

*Word initial stop consonants.* - Both the release duration and the extent of voicing show strongly significant differences between the categories /fortis/ and /lenis/. The release duration of fortis stops in the groups *E* and *S* is considerably longer than that of lenis stops. The fortis stops of the English informants are completely voiceless, whereas occasional voicing is present in the fortis stops of the Finnish informants. Gimson (1966:148) advises foreign learners to pay particular attention to aspiration in an initial position in accented syllables; the English listener may interpret lack of aspiration in such position as a mark of the lenis consonant. As in Suomi's study on English stops, the Finnish students have "overshot" the model production of the English speakers, and the difference in the release duration between fortis and lenis stops is even more drastic with group *S* than with group *E*. This clearly shows that Mazzarella (1971:19) tells only half the truth in maintaining that failure to aspirate /ptk/ would be one of the greatest difficulties for a Finnish learner. In Suomi's study mentioned above, the less advanced Finnish group (with no further studies in English after school) failed to produce the difference of release duration between fortis and lenis stops as markedly as the English speakers. On the other hand, the more advanced Finnish group, (the same as group *S* in the present study) exceeded the model given by the English group (see Suomi 1976:18-19). The present writer offers the following explanation to this phenomenon.

At comprehensive school and at high school the teaching of the required grammar and vocabulary takes so much time that teaching of pronunciation is very limited. So an individual with no studies of English after school has therefore perhaps never been taught to produce the difference between fortis and lenis stops with the help of aspiration. He also fails to produce word initial stops with sufficient voice, as was made apparent in Suomi's study. The more advanced Finnish group, on the other hand, has received systematic teaching of pronunciation at the university. They have been made aware of the phenomena *aspiration* and *voice*. Now they know that /ptk/ are distinguished from /bdg/ through aspiration and voice, and they apply these new concepts so strongly that they exceed the model given by their English teachers. Mazzarella's point that Finnish learners fail to produce aspirated /ptk/ is therefore correct only so far as a certain group of learners is concerned.

Many textbooks maintain, and for the most part correctly, that initial /bdg/ are often fully or partially devoiced (see e.g. Jones 1969:140, Gimson 1966:174). Although initial stops can be devoiced, the extent of voicing shows a strongly significant difference in both groups. Again, as in Suomi's study, the Finnish group exceeded the model given by the English group. According to Jones (1969:44) foreign learners often tend to substitute unaspirated fortis stops for the corresponding lenis ones.

It is clear that this statement only holds good for a certain group of learners (the less advanced, with no studies of English after school, see Suomi 1976:18). However, group *S* showed a clear pronunciation mistake at this point: occasional voicing of fortis stops. This shows that lack of aspiration can sometimes emerge even at university level. This mistake should be eliminated: the data of the English group show that fortis consonants in English are typically voiceless throughout.

*Word initial affricate consonants.* – In the word initial affricate consonants also, both release duration and the extent of voicing show strongly significant differences in both informant groups between the categories /fortis/ and /lenis/. In group *S*, the difference in release duration is less marked, but still significant. Even in affricates, the release duration (the duration of the fricative element) is significantly shorter in the lenis consonants. This is probably due to the fact that fortis consonants tend to be generally longer than the corresponding lenis ones (see. e.g. Fintoft & Selnes 1971:33); duration may be used as a cue for voicing. In fact, duration may be a very important cue at this point, because it seems that initial affricates are not so strongly voiced as e.g. initial stops. Especially in group *S*, the extent of voicing is even shorter than the release duration. It is possible that the notably small amount of voicing in the lenis affricates may cause misunderstanding. The voicing difficulty mentioned by Jones may be even stronger here than in connection with the initial stop consonants. The fortis – lenis distinction of word initial affricates is exemplified by oscillograms in Figure 1. [1]

*Word initial fricative consonants.* The duration of the consonant itself (FD) seems to have some value as a perception cue; the fortis fricatives are considerably longer than the lenis ones in group *E*. The Finnish group, however, has failed to differentiate the duration between

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[1] Figures 1 - 18 in Appendix 4.

fortis and lenis fricatives markedly enough for the difference to be significant. Voicing seems to be perhaps the most important perception cue here: both groups show clear and strongly significant differences.

The overall longer duration of fortis consonants being a more or less important perception cue in all positions may call for some special attention. For example, lenis fricatives have an overall lower intensity than fortis fricatives. This is connected with the force of articulation: greater force – higher intensity – longer duration, and less force – lower intensity – shorter duration. Malécot (1970: 1591 - 1592) maintains that the force of articulation is a case of synesthesia. It has been proved that force of articulation has little or nothing to do with articulatory energy; it is the feeling that fortis consonants are produced with greater articulatory force than lenis ones that makes the fortis consonants somewhat longer. The Finnish informants have failed to make the difference of duration marked enough.

This might be explained by the fact that the duration of initial fricatives has no distinctive role in Finnish. The distinction in actual voicing, on the other hand, is clear because the Finnish students of English are aware that fortis and lenis fricatives are distinguished by, among other things, voice. The fortis – lenis distinction of word initial fricatives is further exemplified through oscillograms in Figure 2.

As for vowel duration after word initial consonants, the duration of the stressed vowel does not present significant differences in either vowel category. This is the reason for vowel duration not being specified for the three consonant classes, but, instead, for the results being pooled from the different manners of articulation. Vowels do not even appear to be systematically longer after fortis consonants, as was the case in Suomi's study (cf. Suomi 1976:18). This is probably due to the fact that Suomi's study was only on stops and the segmentation techniques used in the case of stop consonants: when the duration of the vowel is measured from the instant that voicing begins after initial aspiration, vowels will naturally be shortened after strongly aspirated fortis stops (ibid: 23). When, however, other consonant classes are included, the difference in vowel duration will become smaller and actually disappear.

2.3. Word Medial Position

The results of the present study for the word medial consonants are presented in Tables 3 - 4.

*Word medial stop consonants.* In Lisker's experiments (1957:42-49), the average closure duration of /p/ was 120 msec and that of /b/ 75 msec. When the closure duration was reduced from 130 to 65 msec, listeners reported hearing /b/ instead of /p/. When the duration of the included stop was varied in 10 msec steps over a 40 - 150 msec range, the closure duration for which opinions were divided equally between /p/ and /b/ lay between 70 and 80 msec. Lisker maintains that closure duration is a major cue for the fortis – lenis distinction in intervocalic stops. He concludes that closure durations shorter than 75 msec will always be heard as lenis, and closure durations longer than 130 msec will always be heard as fortis.

The results obtained by the present writer do not agree with the foregoing conclusion. Instead, they correspond very closely with the results obtained by Suomi (1976:29); the difference in the silent interval is nonsignificant, although the silent interval of fortis stops is somewhat longer than the closure duration of lenis stops. On the basis of the present study at least we must therefore reject the idea that closure duration would be an important perception cue for the fortis – lenis distinction of word medial stops. As regards release duration, Slis and Cohen (1969:85) report that the noise burst of lenis stops has a shorter duration than that of fortis stops. This is proved by the results of the present study: the release duration of fortis stops is longer. As for the total duration, the difference between fortis and lenis stops is strongly significant in group *E*, but only almost significant in group *S*. Now the total duration is essentially a combination of the closure and release durations; the Finnish group has longer closure durations but shorter release durations than the English group; when these two parameters are combined, the difference in the combination becomes more marked in group *E*. The most important perception cue to the fortis – lenis distinction of word medial stops seems to be voicing. This corresponds closely with previous experiments and published sources on the subject; lenis stops tend to be fully voiced in intervocalic position.

*Word medial affricate consonants.* Contrary to the case with stops, the difference in the duration of the stop element (SI) between fortis and

Tables 3 - 4. *Word medial consonants.* Parameters silent interval (SI), release duration (RD) and the extent of voicing (EV) of stops and affricates, friction duration (FD) and the extent of voicing of fricatives, and the duration of the preceding vowel (VD) in the categories /tense/ and /lax + æ,e/ and the statistical significance of the difference of means.

Table 3. Group E.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /stop/ | 73 | 23 | 12 | 54 | 12 | 12 | 19 | non |
| RD /stop/ | 44 | 21 | 12 | 11 | 9 | 12 | 33 | +++ |
| TD /stop/ | 114 | 25 | 12 | 68 | 14 | 12 | 46 | +++ |
| EV /stop/ | 0 | 0 | 12 | 65 | 15 | 12 | -65 | ++++ |
| SI /affr/ | 80 | 10 | 6 | 48 | 3 | 6 | 32 | +++ |
| RD /affr/ | 93 | 15 | 6 | 53 | 12 | 6 | 40 | ++ |
| TD /affr/ | 173 | 21 | 6 | 102 | 10 | 6 | 71 | +++ |
| EV /affr/ | 0 | 0 | 6 | 48 | 89 | 6 | -48 | ++++ |
| FD /fric/ | 139 | 34 | 12 | 76 | 17 | 12 | 63 | +++ |
| EV /fric/ | 0 | 0 | 12 | 71 | 16 | 12 | -71 | ++++ |
| CD /tense/ | 118 | 32 | 15 | 148 | 17 | 15 | -30 | + |
| VD /lax + æ,e/ | 88 | 39 | 15 | 118 | 36 | 15 | -30 | non |

Table 4. Group S.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /stop/ | 98 | 41 | 12 | 79 | 28 | 12 | 19 | non |
| RD /stop/ | 28 | 11 | 12 | 0 | 0 | 12 | 28 | ++++ |
| TD /stop/ | 127 | 41 | 12 | 79 | 28 | 12 | 48 | + |
| EV /stop/ | 0 | 0 | 12 | 79 | 28 | 12 | -79 | ++++ |
| SI /affr/ | 63 | 6 | 6 | 83 | 15 | 6 | -20 | non |
| RD /affr/ | 125 | 13 | 6 | 75 | 22 | 6 | 50 | ++ |
| TD /affr/ | 188 | 10 | 6 | 158 | 30 | 6 | 30 | non |
| EV /affr/ | 0 | 0 | 6 | 158 | 30 | 6 | -158 | ++++ |
| FD /fric/ | 143 | 13 | 12 | 100 | 35 | 12 | 43 | ++ |
| EV /fric/ | 0 | 0 | 12 | 80 | 52 | 12 | -80 | ++++ |
| VD /tense/ | 194 | 45 | 15 | 177 | 39 | 15 | 17 | non |
| VD /lax + æ,e/ | 123 | 65 | 15 | 153 | 58 | 15 | -30 | non |

lenis affricates is strongly significant in group *E*. Group *S* has failed to follow the model articulation; the reason for this is difficult to explain. One reason might be that affricates are strange sounds for Finnish learners; they might not know how to "cope with" these new sounds, and this leads to the difficulties revealed here.

The release duration, i.e. the homorganic fricative element, of the fortis affricates is significantly longer in both groups. As for the total duration, fortis affricates are considerably longer than their lenis counterparts in group *E*. In the Finnish group the difference remains nonsignificant. This is explained by the duration of the stop element (SI), which was longer in the lenis affricates although the opposite should have been the case.

The extent of voicing is again the most important perception cue: there are strongly significant differences in both groups. However, the Finnish group's lenis affricates are voiced throughout, but under half the total durations of the English group's lenis affricates are voiced. The fortis – lenis distinction is still carried by a strongly significant difference in voicing, because the fortis affricates are completely voiceless, but it is difficult to find an explanation to the powerful devoicing in the English group.

This subject may be concluded by stating that all four parameters (silent interval, release duration, total duration and the extent of voicing) are important to the fortis – lenis distinction of word medial affricates; the most important of these is the voicing of lenis affricates.

*Word medial fricative consonants.* In intervocalic position the total durations of all consonants can be measured, we can also compare the durations in different consonant classes (see Tables 5 - 6 below). The lenis fricatives of the Finnish group are slightly longer than those of the English group, but the difference is still significant. The differences of voicing are strongly significant in both groups, and fortis fricatives are completely voiceless. Although not even word medial fricatives are fully voiced, this has no consequence as fas as correct perception is concerned. Conclusion: both consonant duration and voicing are important to the fortis – lenis distinction of word medial fricatives, voicing being perhaps the most prominent of these. Slis and Cohen (1969: 88) report a mean difference of 50 msec in length between fortis and lenis

fricatives in Dutch; here the difference is 63 msec for English, and it is strongly significant.

Vowels preceding word medial fortis consonants are somewhat shorter than those preceding lenis consonants in the same position. The difference in duration is nonsignificant, however, and thus the conclusion can easily be drawn that this difference in vowel duration has no value as a phonetic cue.

Tables 5 - 6. *Word medial consonants.* Comparisons of the total durations of intervocalic stops, fricatives and affricates in the categories /fortis/ and /lenis/.

Table 5. Group *E*.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| TD /stop/ | 114 | 25 | 12 | 68 | 14 | 12 | 46 | +++ |
| FD /fric/ | 139 | 34 | 12 | 76 | 17 | 12 | 63 | +++ |
| TD /affr/ | 173 | 21 | 6 | 102 | 10 | 6 | 71 | +++ |

Table 6. Group *S*.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| TD /stop/ | 127 | 41 | 12 | 79 | 28 | 12 | 48 | + |
| FD /fric/ | 143 | 13 | 12 | 100 | 35 | 12 | 43 | ++ |
| TD /affr/ | 188 | 10 | 6 | 158 | 30 | 6 | 30 | non |

The ratios of fortis and lenis consonants in the three manners of articulation are very close to each other in group *E*: fortis stops are 40,4% longer than lenis stops, fortis fricatives 45,3% longer than lenis fricatives, and fortis affricates 41% longer than lenis affricates. As for the durations of the different consonant classes, stops are the shortest and affricates the longest, fricatives taking an intermediate position. The corresponding percentages between the duration of fortis and lenis consonants in group *S* are 37,8% for stops, 30,1% for fricatives and only 16% for affricates, where the difference of duration has remained nonsignificant. Stops are also the shortest in group *S*, fricatives intermediate and affricates the longest in both the categories /fortis/ and /lenis/. The absolute durations of all intervocalic consonants are invariably longer in group *S* than in group *E*.

The fortis – lenis distinction of word medial consonants is further exemplified through oscillograms in Figures 3 - 5.

2.4. Word Final Position: Word Final Consonants Preceded by a Vowel

The results of the phonetic analysis, as regards word final consonants preceded by a vowel, are summarized in Tables 7 - 8. Here the duration of the preceding vowel (VD) has been calculated separately for stop and fricative consonants. Unfortunately, due to the nature of the test material, it was not possible to gather information on vowel duration before affricate consonants. If the preceding vowel was preceded by /r/, such a boundary did not, in fact, exist; /r/ is a glide, and its boundaries cannot be determined.

There is no information on the duration of lax vowels before fricatives, because no satisfactory test material was found.

Tables 7 - 8. *Word final consonants preceded by a vowel.* Parameters silent interval (SI) and the extend of voicing (EV) of stops, the duration of the preceding vowel (VD) in the categories /tense/ and /lax+æ , e/ before stops; silent interval, release duration (RD), total duration (TD) and the extent of voicing of affricates; friction duration (FD) and the extent of voicing of fricatives, and the duration of the preceding /tense/ vowel before fricatives; the duration of the preceding vowel before word final consonants in general in the categories /tense/ and /lax + æ,e/.

Table 7. Group E.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /stop/ | 124 | 33 | 57 | 86 | 31 | 57 | 38 | ++++ |
| EV /stop/ | 0 | 0 | 57 | 54 | 37 | 57 | -54 | ++++ |
| VD /tense/ | 167 | 34 | 21 | 268 | 37 | 21 | -101 | ++++ |
| VD /lax + æ, e/ | 120 | 47 | 36 | 169 | 52 | 36 | -49 | +++ |
| SI /affr/ | 117 | 35 | 12 | 100 | 42 | 12 | 17 | non |
| RD /affr/ | 209 | 64 | 12 | 188 | 52 | 12 | 21 | non |
| TD /affr/ | 286 | 65 | 12 | 266 | 65 | 12 | 20 | non |
| EV /affr/ | 0 | 0 | 12 | 65 | 65 | 12 | -65 | ++++ |
| FD /fric/ | 213 | 94 | 36 | 127 | 49 | 36 | 86 | +++ |
| EV /fric/ | 0 | 0 | 36 | 35 | 47 | 36 | -36 | ++++ |
| VD /tense/ | 157 | 37 | 30 | 296 | 58 | 30 | -139 | ++++ |
| VD /tense/ | 157 | 36 | 66 | 282 | 60 | 66 | -125 | ++++ |
| VD /lax + æ,e/ | 108 | 38 | 69 | 162 | 55 | 69 | -54 | ++++ |

Table 8. Group S.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /stop/ | 113 | 31 | 57 | 96 | 30 | 57 | 17 | + |
| EV /stop/ | 0 | 0 | 57 | 71 | 42 | 57 | -57 | ++++ |
| VD /tense/ | 222 | 34 | 21 | 233 | 64 | 21 | -11 | non |
| VD /lax + æ,e/ | 139 | 40 | 36 | 174 | 41 | 36 | -35 | ++ |
| SI /affr/ | 83 | 21 | 12 | 116 | 28 | 12 | -33 | + |
| RD /affr/ | 218 | 44 | 12 | 165 | 18 | 12 | 53 | ++ |
| TD /affr/ | 300 | 65 | 12 | 271 | 21 | 12 | 29 | + |
| EV /affr/ | 0 | 0 | 12 | 229 | 74 | 12 | -229 | ++++ |
| FD /fric/ | 148 | 71 | 36 | 124 | 45 | 36 | 24 | non |
| EV /fric/ | 0 | 0 | 36 | 62 | 78 | 36 | -62 | ++++ |
| VD /tense/ | 237 | 64 | 30 | 252 | 84 | 30 | -15 | non |
| VD /tense/ | 234 | 54 | 66 | 247 | 75 | 66 | -13 | non |
| VD /lax + æ, e/ | 123 | 38 | 69 | 165 | 64 | 69 | -42 | +++ |

*Word final stop consonants.* With one exception, all the parameters of stop consonants present more or less significant differences between fortis and lenis stops in both groups. The difference in voicing also exists in this position; this is mainly due to the fact that fortis stops are completely voiceless. The degree of voicing varies according to their position in the utterance: there is less voicing in utterance final position, i.e. preceding silence, or before a voiceless sound. More voicing can be expected in the middle of an utterance, before a vowel or a voiced consonant. As might be expected, vowels are considerably longer before lenis stops in both vowel categories in the English group. The Finnish group, however, has succeeded in making this difference only with the lax vowels, and even here to a lesser degree than the English speakers. The fortis – lenis distinction of word final stops is shown through oscillograms in Figures 6 - 9.

*Word final affricate consonants.* Group E presents a significant difference only in the voicing parameter of word final affricates. Group S, on the other hand, has succeeded in making more or less significant differences in all parameters. However, the greatest difference in group S is also in the voicing parameter. Another thing is the great degree of devoicing in the lenis affricates of group E. Only 24% of the total duration is covered by voicing; in the Finnish group, the corresponding percentage is 85%.

There is no information on the mean duration of vowels before word final affricates, but on the basis of the oscillograms in Figure 10 with considerable certainty the conclusion can be drawn that vowels are lengthened before word final lenis affricates, and the longer duration of the preceding vowel is an important parameter of the fortis – lenis distinction.

*Word final fricative consonants.* – Here again, the differences between fortis and lenis consonants are strongly significant in all the parameters in group *E*: fortis fricatives are considerably longer than lenis ones, there is a clear distinction of voicing because fortis fricatives are completely voiceless, and tense vowels are longer when preceding lenis fricatives. Group *S* has failed to make sufficiently sharp distinctions, except for the voicing parameter. As regards friction duration and preceding vowel duration, the distinctions made by the Finnish speakers are in the right direction, the differences are negligible and not sufficiently marked.

The fortis – lenis distinction of word final fricatives is shown through oscillograms in Figure 11.

*Closer examination of the word final fortis – lenis distinction, and the pronunciation difficulties of Finnish speaker.* – There are two parameters in the speech of the English informants that always present significant differences between word final fortis and lenis consonants: vowel duration and the extent of voicing. The degree of voicing of word final lenis consonants depends on the position of the word in the utterance: word final lenis consonants can be more or less voiced, or even completely voiceless. The duration of the closure period is compared to the extent of voicing, in affricates the total duration and in fricatives the friction duration in Table 9 below.

In group *E*, the degree of voicing varies considerably between the different manners of articulation; it is greatest in stops and smallest in affricates, the fricatives taking an intermediate position. In group *S* the degree of voicing is greatest in affricates and smallest in fricatives, and stops are now in the intermediate position. The differences between word final lenis consonant duration and the extent of voicing are strongly significant in all consonant classes in group *E*; the Finnish group tend to use more voice, so that the differences are less marked, and at one point even nonsignificant.

Table 9. Word final consonants. Comparison of word final lenis consonant duration and the extent of voicing in stops, affricates and fricatives.

| | consonant duration | | | extent of voice | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| *stops* | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{CD}-\bar{X}_{EV}$ | p |
| group E | 86 | 36 | 54 | 54 | 37 | 54 | 32 | ++++ |
| group S | 96 | 30 | 54 | 71 | 42 | 54 | 25 | ++ |
| *affricates* | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{TD}-\bar{X}_{EV}$ | p |
| group E | 266 | 65 | 12 | 65 | 65 | 12 | 201 | ++++ |
| group S | 271 | 21 | 12 | 229 | 74 | 12 | 42 | non |
| *fricatives* | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{FD}-\bar{X}_{EV}$ | p |
| group E | 127 | 49 | 36 | 35 | 47 | 36 | 92 | ++++ |
| group S | 124 | 45 | 36 | 62 | 78 | 36 | 62 | +++ |

The duration of the preceding vowel is the most important and most consistent parameter of the word final fortis – lenis distinction. This is also confirmed by the general tendency that while the English group has strongly significant differences in both vowel categories, the Finnish group has succeeded in making the distinction sufficiently marked for the lax vowels only.

In some experiments on the fricatives /s/ and /z/ Denes (1955) discovered that the effect of vowel duration is not independent of the duration of the following consonant, and vice-versa. The perception of voicing in the final consonant segment increases as the ratio of the duration of the final consonant to the preceding vowel decreases: the longer the vowel and shorter the consonant – the more the perception of voicing. This indicates that, although preceding vowel duration is perhaps the most important cue to the word final fortis – lenis distinction, the distinction is most strongly carried by a combination of features, and one of these being that the unvoiced lenis consonants still remain lenis – e.g. are shorter in duration than the corresponding fortis consonants. This is noticeable as regards the English informants in the present study also; only affricates form an exception. Raphael (1972:1296 - 1303) discovered that synthesized words with cues for voicing in the final consonant segment were perceived as voiced following vowels which were of shorter duration than those with cues for voicelessness. Raphael concludes that preceding vowel duration is a sufficient and necessary cue to the perception of the voicing of word final lenis consonants. The presence of voicing in the consonant segment

does not have the same value, but it makes correct perception easier.

The question whether the lengthening of vowels before voiced consonants is a phenomenon specific to the English language only, or whether vowels are universally longer in this position was investigated by Chen (1970:129 - 159). He examined the effect of the fortis – lenis distinction in English, French, Russian and Korean. In all four languages a vowel was invariably longer before a lenis consonant than before a fortis one. A certain cross-linguistic validity of the statement that vowels generally tend to become longer before lenis consonants seems to exist. However, in Chen's experiments the voicing of the adjacent consonant influenced its preceding vowel to different degrees in different languages: in English the ratio of vowel duration before fortis consonants to that before lenis ones was 0,61, and in Spanish the ratio was 0,87. Chen concludes that the variation of vowel duration as a function of the voicing of the following consonant is presumably a language-universal phenomenon. The extent, however, to which the adjacent fortis or lenis consonant affects the duration of its preceding vowel is determined by a language-specific phonological structure. For a more extensive review of recent work see Hänninen 1978.

From a linguistic point of view, the variation of vowel length in inverse proportion to the closure time of the following consonant might reflect the speaker's tendency to maximize the perceptual distance between fortis and lenis consonants: the simultaneous reduction of vowel duration and the prolongation of the following consonant would heighten the perceptual effect of voicelessness. Conversely, the simultaneous lengthening of vowel and shortening of consonant would concur as acoustic cues for voicing. Finally, although it seems that the lengthening of vowels before word final lenis consonants is at least to some extent a language-universal phenomenon, the remarkable durational differences in English vowels may be seen as a perceptual device serving a distinctive function in the phonological system of the English language.

The Finnish informants have systematically failed to make significant the distinction of tense vowels preceding fortis and lenis consonants. The differences of lax vowels in the same context, however, show some statistical significance. According to many published sources, it is the tense vowels that are most remarkably lengthened before word final

lenis consonants (see e.g. Jones 1969:135; Mazzarella 1971:20). This also holds good for the results of the present study. Tense vowels are 37,7% longer before lenis stops than before fortis ones. The same figure for lax vowels preceding stop consonants is 28,9% in group *E*. When all word final consonants are taken into account, tense vowels preceding lenis consonants are 44,3% longer than those preceding fortis ones; for the lax vowels, the corresponding figure is 33,3%. In group *S* the differences of tense vowels are systematically nonsignificant, and even the differences of lax vowels are less than that of group *E*. The lax vowels of group *S* are 20,1% longer before lenis stops than before fortis ones; with all word final consonants taken into account, the corresponding figure is 25,5%. According to Jones (1969:23) one of the most notable mistakes made by foreign speakers of English is the failure to shorten long vowels and diphthongs before fortis consonants. Mazzarella (1971:20) specifies that, when Finnish speakers are in question, the difficulty lies primarily in a tendency to make tense vowels and diphthongs before fortis consonants too long. This tendency is also clearly noticeable in the present study.

A few reasons for such a situation can be introduced. Vowel duration variations in Finnish are to a large extent determined by *preceding* sounds. In Finnish, a double vowel in the preceding syllable, or a geminate consonant at a syllable boundary, tends to reduce the duration of the following vowel, whereas a short vowel in the preceding syllable tends to increase the length of the vowel in question (see Lehtonen 1972:34). Moreover, Finnish is a quantity language; the Finnish speaker/listener is accustomed to classifying the sounds heard as "long" or "short" or as "single" and "double" sounds. Similarly, he is accustomed in his own language to make the sounds classified as "long" about twice as long as those classified as "short". A Finnish speaker is not accustomed to the fact that the English "long" (i.e. *tense*) vowels must be radically shortened in certain environments, to such an extent that they can become shorter than vowels traditionally defined as "short" (i.e. *lax*); in fact, the mean duration of tense vowels before fortis stops is 2 msec less than that of lax vowels before lenis stops in group *E* (see Tables 7-8; p. 108-). Spelling can also have some effect: even in English, tense vowels are represented in writing by two vowel graphs, which, of course, need not be similar,

whereas lax vowels are represented by one vowel graph only. This, and the factors dealt with above, results in the Finnish speaker always making tense vowels considerably longer than lax vowels; the tense vowels before fortis consonants thus become too long.

There is also a factor inherent in the system of vowel durations in English that causes difficulties for the Finnish speaker. As was stated above, a Finnish speaker primarily perceives the difference *tense-lax* as a difference of duration. The most important perception cue, in the tense-lax complex for a native English speaker, is often vowel quality, which can vary widely in different contexts (see e.g. Muskat-Tabakovska 1970:105).

The fortis – lenis distinction seems to have no systematic effect on the duration of the word final consonant. Only in the case of fricatives, has a strongly significant difference of group *E* remained nonsignificant in group *S*. The lenis fricatives are of about the same duration in both groups, but the fortis fricatives of group *S* are considerably shorter than those of group *E*. This is probably caused by the common mistake of Finnish speakers stated by Mazzarella (1971:19). /s/ is not pronounced sharply enough, the force of articulation is weaker, and, consequently, duration decreases. Consonant duration in word final position is, on average, considerably longer in lenis consonants than the extent of voicing. Thus, voicing must not be given too much weight as a parameter of the fortis – lenis distinction in this position. Consequently, Mazzarella's argument that, in the case of word pairs like *let* and *led*, the most important perception cue would be the voicing of the final consonant, is somewhat open to doubt.

2.5. Word Final Position: Word Final Consonants Preceded by Another Consonant

Two different cases concerning word final consonants preceded by another consonant were included in the study: the first was fricative and stop consonants preceded by a sonorant (/n/, /l/), and the second, stop consonants preceded by an obstruent (/s/, /z/). The results are presented in Tables 10 - 11. Fortis fricatives are significantly longer than lenis ones when preceded by a sonorant consonant, in the same way as when preceded by a vowel. A significant difference also exists in the extent.

Tables 10 - 11. *Word final consonants preceded by another consonant.* Parameters: Friction duration (FD) and the extent of voicing (EV) of fricatives, VD/tense/ preceding an obstruent + stop, the duration of an obstruent preceding a stop (PCDobs/stop), VD/lax/ preceding a sonorant followed by a stop and/or a fricative (VD/lax/son/stop+fric, VD/lax/son/stop, VD/lax/son/fric, and the duration of the preceding sonorant followed by a stop and/or a fricative (PCDson/stop+fric, PCDson/stop, PCDson/fric).

Table 10. Group *E*.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| FD/fric/ | 253 | 35 | 12 | 167 | 28 | 12 | 86 | ++++ |
| EV/fric/ | 0 | 0 | 12 | 53 | 32 | 12 | -53 | ++++ |
| VD/tense/ obs+stop | 133 | 37 | 12 | 263 | 83 | 12 | -130 | ++++ |
| PCDobs/ stop | 163 | 71 | 12 | 108 | 70 | 12 | 55 | non |
| VD/lax/son/ stop+fric | 88 | 22 | 18 | 106 | 40 | 18 | -18 | non |
| VD/lax/ son/stop | 72 | 14 | 6 | 68 | 10 | 6 | 4 | non |
| VD/lax/ son/fric | 96 | 21 | 12 | 124 | 36 | 12 | -28 | non |
| PCDson/ stop+fric | 112 | 53 | 18 | 232 | 47 | 18 | -120 | ++++ |
| PCDson/ stop | 58 | 12 | 6 | 115 | 18 | 6 | -57 | +++ |
| PCDson/ fric | 138 | 43 | 12 | 291 | 51 | 12 | -153 | ++++ |

of voicing, mainly because fortis fricatives are completely voiceless. The degree of devoicing of lenis fricatives is rather strong: EV comes to 31,7% of FD in group *E*, and the Finnish group's lenis fricatives are completely voiceless.

In the sequences of tense vowel/diphthong + obstruent consonant + stop (word pairs like *post – posed, east – eased*), the most significant feature is the duration of the vowel or diphthong. The vowel segment is considerably longer in *posed, eased* than in *post, east*. The consonant element /s/, /z/, is not appreciably affected by the fortis – lenis distinction.

Table 11. Group S.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - X_l$ | p |
| FD/fric/ | 202 | 27 | 12 | 188 | 23 | 12 | 14 | non |
| EV/fric/ | 0 | 0 | 12 | 0 | 0 | 12 | 0 | non |
| VD/tense/ obs+stop | 213 | 67 | 12 | 243 | 51 | 12 | 30 | non |
| PCDobs/ stop | 101 | 29 | 12 | 108 | 34 | 12 | -7 | non |
| VD/lax/son/ stop+fric | 93 | 29 | 18 | 101 | 36 | 18 | -8 | non |
| VD/lax/ son/stop | 92 | 26 | 6 | 60 | 5 | 6 | 12 | non |
| VD/lax/ son/fric/ | 104 | 26 | 12 | 121 | 25 | 12 | -17 | non |
| PCDson/ stop+fric | 119 | 30 | 18 | 136 | 24 | 18 | -17 | non |
| PCDson/ stop | 103 | 28 | 6 | 117 | 15 | 6 | -14 | non |
| PCDson/ fric | 128 | 30 | 12 | 146 | 23 | 12 | -18 | non |

In sequences lax vowel + sonorant (/n/, /l/) + stop/fricative, the duration of the vowel does not exhibit any significant differences. On the basis of the present results Chen's argument (1970:148-150) that vowel duration would vary notably even when separated from the final obstruent by an intervening sonorant, and that the voicing of the consonantal environment would exercise durational influence on the vowel – sonorant sequence as a whole, is not correct.

It seems, therefore, that the basis on which an English-speaking person discriminates as to whether he hears *since* or *sins* is primarily the duration of the /n/. On the other hand, e.g. *post* and *posed* are discriminated, apart from context, mainly through the duration of the diphthong [əu]. The importance of vowel duration in words where the vowel is separated from the final obstruent by an intervening consonant varies according to the nature of the vowel itself, and the nature of the intervening consonant.

The Finnish group has not succeeded in making any fortis – lenis distinction at all, because all the parameters included in the fortis – lenis distinction of word final consonants preceded by another consonant only show nonsignificant differences. In connection with word final fricatives preceded by a vowel, the Finnish informants already proved unable to make the durational difference between fortis and lenis fricatives clear enough. We are faced with the same problem here: the fortis fricatives (especially /s/) are too short, and the lenis fricatives (especially /z/) too long. The voicing opposition has been completely neutralized in the Finnish informants' speech – both fortis and lenis fricatives are completely voiceless. This, of course, would not be a fault if there were significant differences in other parameters involved in the same distinction, but, as this is not the case, it is to be expected that native English speakers would find it difficult to identify these words correctly.

In the sequences of a tense vowel or diphthong followed by two obstruents (*post – posed, east – eased*) group *S* makes the vowels before fortis consonants too long, and thus the difference of vowel duration becomes negligible. The only point where group *S* has been able to follow the model given by group *E* is lax vowel duration in the sequences of lax vowel + sonorant + obstruent: both groups exhibit only nonsignificant differences. But when we proceed to the next parameter, the duration of the sonorant in the sequences in question, there are some very interesting observations to make. When all word final consonants in this position are taken into account it seems that group *S* has failed to make the sonorants preceding lenis obstruents sufficiently long. Upon closer examination of the results, however, group *S* can be seen to have made two kinds of mistakes: in the word pair *built – build* the /l/ in *built* is too long; on the other hand, in word pairs *since – sins, fence – fens*, the /n/ in *sins, fens* is too short (cf. Figures 12 - 13). It is difficult to explain why the Finnish group have made mistakes in both directions, but a few words of explanation can be offered as to why the Finnish informants have failed to produce the durational difference of the preceding consonant. The Finnish consonants are subject to strong restrictions of distribution. In Finnish, consonant combinations like the ones dealt with above, are non-existent. In their own language, the

Finnish informants are unaccustomed to such consonant combinations and durational variations in the same position. In the English informants' speech, the /n/ in *sins, fens* is, on average, 110% longer than in *since, fence*; the ratio is about the same as that between the Finnish single and geminate consonants. Here, therefore, there is a kind of double effect causing difficulties for the Finnish speaker: consonant combinations unfamiliar in the mother tongue, and variations of consonant duration which, although as marked as in Finnish, are in a completely unfamiliar position. The fortis – lenis opposition of word final consonants preceded by another consonant is shown through oscillograms and spectrograms in Figures 12 - 16.

2.6. Differences in the Realization of the Fortis – Lenis Distinction in Single Words, Word Groups and Sentences

On the three different utterance environments of the phonetic analysis, the single word and the sentence can be considered as real speech situations: the sentence, of course, is the primary situation; it is self-evident that the most natural environment in which a speech sound appears is a sentence. Separately uttered words are perhaps not as common in every-day speech as sentences, but they are far from being uncommon. Groups, or stretches, of separately uttered words, hardly appear in every-day speech, however.

When the present study was undertaken, the assumption concerning the durations of phonetic segments was that durations would be longest in separate words and shortest in sentences, the word groups taking an intermediate position. Whether this assumption was correct or not, will in the following be examined only as far as the word final position is concerned. To start with, however, the durations of phonetic segments in general in the three different environments should be examined. Vowel duration in the categories /tense/ and /lax/ has been chosen as an example. The results are presented in Tables 12 – 13. With one exception, vowel durations are longest in single words and shortest in sentences, word groups being somewhere in between. However, the differences are surprisingly small, especially in group *E*. Differences between single words and word groups are negligible in both groups but group *S* consistently shows strongly significant differences between word groups and sentences, whereas group *E* only shows an almost significant difference between word groups

Tables 12 - 13. Differences in vowel duration in the categories /tense/ and /lax/ in single words (W), word groups (G), and sentences (S).

Table 12. Group E.

| | words | | | word groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| VD/tense/ | 233 | 98 | 60 | 202 | 77 | 87 | 197 | 72 | 75 | 31 | non | 5 | non | 36 | non |
| VD/lax/ | 128 | 46 | 51 | 144 | 58 | 56 | 106 | 52 | 83 | -16 | non | 38 | + | 20 | non |

Table 13. Group S.

| | words | | | word groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| VD/tense/ | 271 | 44 | 60 | 263 | 65 | 87 | 208 | 46 | 75 | 8 | non | 55 | ++++ | 63 | ++++ |
| VD/lax/ | 170 | 59 | 51 | 165 | 44 | 56 | 109 | 39 | 83 | 5 | non | 56 | ++++ | 61 | ++++ |

and sentences in lax vowels. This already reveals that the question of sound durations in the three environments is not as straightforward as was assumed. The overall durations of group *S* are somewhat longer than those of group *E*. This is mainly due to the generally slower speaking rate of the Finnish informants. In the following the problem will be dealt with in more detail, and with restriction to parameters affected by the word final fortis – lenis distinction. The following parameters have been chosen as examples of the durations of consonant parameters: the silent interval the friction duration (FD) of fricatives, and the extent of voicing (EV) of fricatives. All the parameters involve the word final position only, and the results are presented in Tables 14 -15 on the following page.

The English group's fortis stops are longer than those of group *S*, while the converse is true as far as lenis consonants are concerned. The Finnish group's fortis stops are longest in word groups, while their lenis stops are shortest in the same environment. Group E shows much more consistency in this respect; the lenis stops especially are shortened in approximately equal stages from single words to sentences. The fortis fricatives of group E are considerably longer than those of group *S*. Otherwise the order of durations is here the one assumed previously, and this time groups *S* presents a decrease of duration in fairly equal stages from single words to sentences.

In lenis fricatives, the differences between the two groups are minimal; differences between single words and word groups are negligible.

It is noteworthy that the extent of voicing is drastically reduced in word groups and sentences in group *E*. Group *S*, on the other hand, shows most powerful voicing in word groups, from which it is again abruptly reduced as compared to sentences. Again, differences between single words and word groups are trivial.

The durational differences found between the three utterance environments will be shown by one more parameter: the effect of the word final fortis – lenis distinction on the duration of the preceding vowel. The durations are presented in Tables 16 - 17, in the vowel categories /tense/ and /lax/ preceding word final fortis and lenis consonants. The differences between single words and word groups are once again consistently nonsignificant. The Finnish group's tense vowels are considerably longer

Tables 14 -15. Comparisons of some consonant parameters in word final position in single words (W), word groups (G) and sentences (S).

Table 14. Group *E*.

| | words | | | words groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| SI/fortis/ | 132 | 38 | 19 | 127 | 18 | 22 | 108 | 36 | 27 | 5 | non | 19 | non | 24 | non |
| SI/lenis/ | 104 | 30 | 18 | 84 | 16 | 18 | 66 | 25 | 24 | 20 | non | 18 | non | 38 | non |
| FD/fortis/ | 269 | 62 | 12 | 268 | 73 | 18 | 177 | 78 | 18 | 1 | non | 91 | + | 92 | + |
| FD/lenis/ | 179 | 35 | 12 | 152 | 40 | 18 | 108 | 37 | 18 | 27 | non | 44 | + | 71 | +++ |
| EV/lenis fric./ | 80 | 95 | 12 | 24 | 27 | 18 | 16 | 33 | 18 | 56 | non | 8 | non | 64 | + |

Table 15. Group *S*.

| | words | | | words groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| SI/fortis/ | 121 | 30 | 19 | 123 | 26 | 22 | 99 | 30 | 27 | -2 | non | 24 | non | 22 | non |
| SI/lenis/ | 108 | 22 | 18 | 89 | 22 | 18 | 91 | 34 | 24 | 19 | non | -2 | non | 17 | non |
| FD/fortis/ | 235 | 42 | 12 | 169 | 49 | 18 | 120 | 51 | 18 | 66 | + | 49 | non | 115 | ++++ |
| FD/fortis/ | 174 | 35 | 12 | 152 | 40 | 18 | 108 | 37 | 18 | 22 | non | 44 | + | 66 | +++ |
| EV/lenis fric./ | 73 | 81 | 12 | 80 | 102 | 18 | 16 | 37 | 18 | -7 | non | 64 | + | 57 | + |

Tables 16 - 17. Differences of vowel duration preceding word final fortis and lenis consonants in single words, word groups and sentences.

Table 16. Group *E*.

| | words | | | word groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| VD/tense,f/ | 149 | 21 | 24 | 163 | 40 | 39 | 148 | 33 | 27 | -14 | non | 15 | non | 1 | non |
| VD/tense,l/ | 287 | 72 | 24 | 334 | 48 | 39 | 258 | 49 | 27 | -49 | non | 76 | +++ | 29 | non |
| VD/lax,f/ | 107 | 27 | 16 | 73 | 12 | 18 | 99 | 31 | 28 | 34 | non | -26 | non | 8 | non |
| VD/lax,l/ | 157 | 54 | 25 | 153 | 37 | 22 | 148 | 57 | 33 | 4 | non | 5 | non | 9 | non |

Table 17. Group *S*.

| | words | | | word groups | | | sentences | | | differences of means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_W-\bar{X}_{WG}$ | p | $\bar{X}_{WG}-\bar{X}_S$ | p | $\bar{X}_W-\bar{X}_S$ | p |
| VD/tense,f/ | 248 | 27 | 24 | 266 | 50 | 39 | 198 | 34 | 27 | -18 | non | 68 | ++++ | 50 | +++ |
| VD/tense,l/ | 272 | 33 | 24 | 328 | 88 | 39 | 212 | 41 | 27 | -56 | non | 116 | ++++ | 60 | +++ |
| VD/lax,f/ | 137 | 29 | 16 | 117 | 15 | 18 | 104 | 26 | 28 | 20 | non | 13 | non | 33 | non |
| VD/lax,l/ | 184 | 72 | 25 | 181 | 38 | 22 | 118 | 37 | 33 | 3 | non | 63 | ++++ | 66 | ++++ |

before fortis consonants than those of the English group, whereas the converse is true as far as lenis consonants are concerned. This again reflects the Finnish speakers' inability to shorten tense vowels sufficiently before fortis consonants.

The relations in the lax vowels are a little less sharply defined: the differences are slight and often nonsignificant.

From the above somewhat random samples chosen to exemplify the durational differences between the three utterance environments, a few conclusions can be drawn. There is very little what we can call "systematic" in these differences. There are no significant differences between single words and word groups, and sound durations are longer in single words than in sentences; there is little else that is systematic. What is most unsystematic are the sound durations in word groups, and an explanation for this is offered in the classification of utterance environments presented above (cf. p.118): a separate word and a sentence are natural utterances, whereas a group of separate words pronounced with sentence intonation very seldom, if ever, appears in natural speech. There are no "natural" durations for sounds in word groups; this offers an explanation, albeit an incomplete one, to the great variation of sound durations in word groups.

As for the differences of sound durations between the two groups of informants, the general tendency is that the Finnish speakers present longer durations than the English ones. This can be at least partly explained by the generally slower speech rate of the Finnish informants, and by the effect of length in Finnish.

2.6.1. Some Comparisons of the Realization of the Fortis-Lenis Distinction in Various Environments

How the parameters included in the word final fortis – lenis distinction are affected in the three utterance environments, will be shown below by a few samples that represent both consonant and vowel durations. The consonant durations will be investigated first; the differences between fortis and lenis consonants in the parameters silent interval of stops and friction duration of fricatives in the three environments are presented in Tables 18 - 19. It is noteworthy that the differences between fortis and lenis consonants are less marked in the Finnish group,

Tables 18 - 19. The effect of word final fortis – lenis distinction on the parameters SI of stops and FD of fricatives in single words (W), word groups (WG) and sentences (S).

Table 18. Group E.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /W/ | 132 | 38 | 29 | 104 | 30 | 28 | 28 | non |
| SI /WG/ | 127 | 18 | 13 | 84 | 16 | 13 | 43 | ++++ |
| SI /S/ | 108 | 36 | 27 | 66 | 25 | 27 | 42 | ++++ |
| FD /W/ | 270 | 62 | 12 | 179 | 35 | 12 | 91 | +++ |
| FD /G/ | 268 | 173 | 12 | 152 | 40 | 12 | 116 | +++ |
| FD /S/ | 177 | 78 | 24 | 108 | 37 | 24 | 69 | ++ |

Table 19. Group S.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| SI /W/ | 121 | 29 | 24 | 108 | 22 | 24 | 13 | non |
| SI /WG/ | 121 | 24 | 13 | 89 | 22 | 13 | 32 | + |
| SI /S/ | 99 | 30 | 27 | 91 | 34 | 27 | 8 | non |
| FD /W/ | 235 | 42 | 12 | 174 | 35 | 12 | 61 | ++ |
| FD /WG/ | 169 | 49 | 12 | 152 | 40 | 12 | 17 | non |
| FD /S/ | 120 | 51 | 24 | 108 | 37 | 24 | 12 | non |

especially in connection with fricatives. The English informants show more or less significant differences in both parameters in all environments, with one exception, viz. the SI in single words. The Finnish informants, on the other hand, are not so consistent, in fact far from it. Especially noticeable is their failure to make the difference between fortis and lenis fricatives sufficiently marked; however, they have succeeded in this with single words.

Another consonant duration parameter examined in this connection is the relation of lenis consonant duration and voicing. The closure duration (CLD) of stops and the friction duration of fricatives are compared to their extent of voicing. The data are presented in Tables 20 - 21.

Tables 20 - 21. Comparison of the closure duration (CLD) of lenis stops and the friction duration (FD) of lenis fricatives, and their extent of voicing (EV) in single words, word groups and sentences.

Table 20. Group *E*.

| | closure duration | | | extent of voicing | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{CLD}-\bar{X}_{EV}$ | p |
| words | 104 | 30 | 21 | 84 | 54 | 21 | 20 | non |
| word groups | 84 | 16 | 12 | 68 | 27 | 12 | 16 | non |
| sentences | 66 | 25 | 24 | 55 | 28 | 24 | 11 | non |
| | friction duration | | | extent of voicing | | | difference of means | |
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{CLD}-\bar{X}_{EV}$ | p |
| words | 179 | 35 | 12 | 81 | 95 | 12 | 98 | + |
| word groups | 152 | 40 | 12 | 24 | 27 | 12 | 128 | ++++ |
| sentences | 108 | 37 | 24 | 16 | 33 | 24 | 92 | ++++ |

Table 21. Group *S*.

| | closure duration | | | extent of voicing | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{CLD}-\bar{X}_{EV}$ | p |
| words | 108 | 22 | 21 | 83 | 36 | 21 | 25 | non |
| word groups | 89 | 22 | 12 | 54 | 40 | 12 | 35 | non |
| sentences | 91 | 34 | 24 | 72 | 45 | 24 | 19 | non |
| | friction duration | | | extent of voicing | | | difference of means | |
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_{FD}-\bar{X}_{EV}$ | p |
| words | 174 | 35 | 12 | 73 | 81 | 12 | 101 | ++ |
| word groups | 152 | 40 | 12 | 80 | 102 | 12 | 72 | non |
| sentences | 108 | 37 | 24 | 16 | 37 | 24 | 92 | ++++ |

The differences between the closure duration and the extent of voicing are nonsignificant throughout. In the fricatives, however, there are more or less significant differences throughout, with one exception, viz. the word groups of group *S*.

The data on the vowel duration variations connected with the word final fortis – lenis distinction are presented in Tables 22 - 23.

Tables 22 - 23. The effect of the word final fortis – lenis distinction on vowel duration in single words, word groups and sentences.

Table 22. Group *E*.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| VD/tense/(W) | 149 | 21 | 15 | 287 | 72 | 15 | -138 | ++++ |
| VD/tense/(WG) | 163 | 40 | 24 | 334 | 48 | 24 | -171 | ++++ |
| VD/tense/(S) | 148 | 33 | 39 | 258 | 49 | 39 | -110 | ++++ |
| VD/lax/(W) | 107 | 27 | 31 | 157 | 54 | 31 | -50 | +++ |
| VD/lax/(WG) | 73 | 12 | 10 | 153 | 38 | 10 | -80 | +++ |
| VD/lax/(S) | 99 | 31 | 30 | 148 | 57 | 30 | -49 | +++ |

Table 23. Group *S*.

| | fortes | | | lenes | | | difference of means | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | s | N | $\bar{X}$ | s | N | $\bar{X}_f - \bar{X}_l$ | p |
| VD/tense/(W) | 248 | 27 | 15 | 272 | 33 | 15 | -24 | non |
| VD/tense/(WG) | 272 | 65 | 24 | 328 | 88 | 24 | -56 | non |
| VD/tense/(S) | 198 | 34 | 39 | 212 | 41 | 39 | -14 | non |
| VD/lax/(W) | 137 | 29 | 31 | 184 | 72 | 31 | -47 | + |
| VD/lax/(WG) | 117 | 15 | 10 | 181 | 38 | 10 | -64 | ++ |
| VD/lax/(S) | 104 | 26 | 30 | 118 | 37 | 30 | -14 | non |

The Finnish group fails to shorten vowels before fortis consonants, especially tense vowels: group *E* here shows strongly significant differences throughout, and group *S* systematically nonsignificant differences. As for the lax vowels, the Finnish informants also have succeeded in making more or less significant differences, with the exception of sentences.

On the grounds of the above data one tentative conclusion can be stated: the differences in the parameters affected by the word final fortis – lenis distinction tend to be greatest in sentences, which have been called primary natural speech situations above.

## 3. RESULTS OF THE PERCEPTION TESTS

The second part of the present work consists of perception tests. An account will be given below on the selection of material for the tests, how they were recorded and how they were performed.

### 3.1. Selection of Perception Test Items

The test items were chosen on the basis that two kinds of perception tests would be made up: one consisting of words and one of sentences (for the items, see Appendices 2 and 3). Another criterion was that the perception tests also should concentrate on the word final cases. Finally 14 words and 24 sentences were selected for the tests.

### 3.2. Recording of the Test Tapes

The test tapes were recorded at the Phonetics laboratory of the University of Jyväskylä, from the recordings made for the phonetic analysis. Each item was recorded three times, i.e. pronounced by each of the three English and the three Finnish informants. In the word tests, words were included both as single words and from word groups; in the latter case, the extra words were removed and only the test word was included. However, the perception of single words and words removed from a word group was treated essentially in the same way. The items were recorded in random order, and the word and sentence tests for Finnish and English subjects were recorded on different tapes. Finally, therefore, there were four tapes: two word tests containing 42 items each and two sentence tests containing 72 items each.

### 3.3. Selection of Subjects

Three groups of subjects (listeners) were chosen. The first group consisted of ten British subjects. This group will be called group *E*. There were two Finnish groups: one consisting of ten students of different subjects, with a 6- or 7 - year course in English at school, but no language studies after school. This group will be called group *S1*. The other Finnish group consisted of ten students of English who had completed a cum laude course in English philology. This group will be called group *S2*.

3.4. Test Performance

The tests were performed in the AA - language laboratory of the University of Jyväskylä. The subjects heard the stimulus words and sentences through earphones. Six different tests were performed, as follows:

| | Speakers | Listeners |
|---|---|---|
| test: word | E | S1 |
| | E | S2 |
| | S2 | E |
| test: sentence | E | S1 |
| | E | S2 |
| | S2 | E |

The tests were planned as forced choice tests, where the subjects had to choose between two given alternatives. For example, they heard the word "cheap" from the tape. They were then supposed to answer whether they heard "cheap" or "jeep". The answers were marked on optic reader forms.

3.5. Analysis of the Results

The results were first transferred onto a magnetic tape by an optic reader at the Centre for Educational Research in Jyväskylä. The tape was analysed by a computer at the Computer Centre of the University of Jyväskylä. Thus percentages of correct and incorrect identifications were obtained, for each group of subjects in the sound categories and word positions included in the tests.

In the following tables the results will be presented so that the word and sentence tests are dealt with separately. However, a comparison will be made between these two test types where possible. The percentages of correct identifications out of the total number of cases will be given for each group of subjects and for fortis and lenis consonants in different positions in a word. The following abbreviations are used: E = English; S1 = the less advanced Finnish group, with no studies in English after school; S2 = the more advanced Finnish group, with a completed cum laude course in English philology.

3.6. Word Tests

*Word initial consonants.* — Two sound pairs were chosen for the word initial position, viz. the stops /t/ - /d/ and the affricates /tʃ/ - /dʒ/. In Table 24 below the results are presented so that first the percentages of correct identifications are given for all word initial consonants in the test, and then the separate results of stops and affricates are specified.

Table 24. Percentages of correct identifications of word initial consonants in word tests. S1 = the less advanced Finnish students, S2 = the more advanced Finnish students of English.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| *All consonants tested* | | | |
| fortis | 95,8 | 95 | 100 |
| lenis | 83,3 | 90 | 98,3 |
| *Stops* | | | |
| /t/ | 95,8 | 100 | 100 |
| /d/ | 100 | 100 | 100 |
| *Affricates* | | | |
| /tʃ/ | 95,8 | 90 | 100 |
| /dʒ/ | 66,7 | 80 | 96,7 |

A first general glance at the table above reveals that the number of correct identifications is fairly high: over 90%, with some exceptions. The first surprising feature is perhaps the English group's relatively low amount of correct identifications of lenis consonants pronounced by Finnish students. It is further proved that this is caused by the pronunciation errors made in affricates, because the /d/:s have been identified 100% right.

Fortis consonants appear to have been identified better than lenis ones, as was expected; it more often happens that lenis consonants are taken for fortis ones than vice-versa.

There is a clear difference between the two manners of articulation: stops have been identified far better than affricates. In fact, an

overall correct identification of 100% was expected for the stops, but for some reason this expectation did not materialise. What is even more surprising is that the errors were made by group E in identifying /t/. The fewer correct identifications in affricates is probably caused by the fact that affricates are completely strange sounds for Finns; they are unaccustomed to distinguish them both in pronunciation and perception.

If we compare the three listener groups, group S2 has done best. Only in two cases out of six is the percentage of correct identifications less than 100%, and even in these cases the amount of errors is very small. Group S1 comes second, while most misunderstanding is found in group E. This is, of course, to be expected. From the results of the phonetis analysis we know that the Finnish speakers do not always produce the fortis – lenis distinction in the same way as the English ones. This, in turn, means that the English listeners do not always distinguish what the Finnish speakers mean to say.

*Word medial consonants*. Only one sound pair was included in the word tests as an example of the perception of word medial consonants, namely the affricates /tʃ/ - /dʒ/. The word pair where the sounds appeared was a subminimal *breeches - bridges*. This pair was included because the phonetic analysis revealed some interesting facts concerning the duration of the stressed vowel in the words. The results of the perception test are presented in Table 25 below.

Table 25. Percentages of correct identifications of word medial affricates in word tests.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| /tʃ/ | 75 | 40 | 70 |
| /dʒ/ | 95,8 | 100 | 100 |

Of special interest here is the considerable number of errors made in identifying the word *breeches* correctly. The less advanced Finnish group (S1) has in fact made more incorrect than correct identifications. This can be explained by the very slight difference in the duration of the stressed vowel in *breeches* and *bridges*.

The voicing of the lenis affricate is also very weak, and the durational difference fairly slight (only 40 msec); so it is not surprising that the word is misinterpreted. The reason for group E misinterpreting 25% of the /tʃ/:s is more complicated; it is known that Finnish speakers tend to make the vowel too long in this position. One possible explanation is that the English listeners have misinterpreted the long vowel duration as a cue for the lenis affricate /dʒ/, because the vowel is in fact lengthened even here, in a medial position, when it is followed by a lenis consonant.

The two 100% identifications of groups *S1* and *S2* in the affricate /dʒ/ have a single explanation: orthography. When a Finnish speaker hears a vowel that he would classify as "short" (about 70 - 90 msec or so) in his mother tongue and simultaneously sees two words with one vowel grapheme in one and two in the other, he will have no hesitation in choosing the one with one vowel grapheme if he is asked which word he heard.

The results of this mini-perception test clearly show that nothing is self-evident in the correct perception of English words and sentences. We would expect that perception would be easiest in word medial position, where, for example, the voicing feature, which has hitherto been perhaps the most prominent in the fortis – lenis distinction, is most powerful; but as was discovered, one must be very careful with such expectations and generalizations.

*Word final consonants.* Most items of the word tests were concentrated on word final cases. The results of the test have been presented in Table 26 as follows: firstly, the percentages of correct identifications of all word final fortis and lenis consonants have been calculated; then the percentages of stops, of which only one word pair, the subminimal *east - eased* was included, are presented. Fricatives have again been dealt with so that, firstly, the percentages for all fortis and lenis fricatives have been calculated; then they have been divided into single fricatives and fricatives preceded by /n/. The single fricatives have first been treated as one group, and then divided into /s/ - /z/ and /f/ - /v/. As for the fricatives preceded by /n/, there is only one word pair, *since - sins*.

Table 26. Percentages of correct identifications of word final consonants in word tests.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| *All consonants tested* | | | |
| fortis | 69,8 | 65,8 | 92,5 |
| lenis | 60,4 | 51,2 | 74,2 |
| *Stops* | | | |
| /t/ | 100 | 83,3 | 100 |
| /d/ | 50 | 86,7 | 100 |
| *Fricatives* | | | |
| fortis | 59,5 | 60 | 90 |
| lenis | 63,8 | 46,7 | 68,9 |
| *Single fricatives* | | | |
| fortis | 41,7 | 60 | 85 |
| lenis | 95,8 | 31,7 | 50 |
| /s/ | 4,2 | 26,7 | 70 |
| /z/ | 91,2 | 13,3 | 36,7 |
| /f/ | 75 | 93,3 | 100 |
| /v/ | 100 | 50 | 63,3 |
| *n + /s/, /z/* | | | |
| /s/ | 95,8 | 60 | 100 |
| /z/ | 0 | 56,7 | 96,7 |

In general fortis consonants seem to have been identified better than lenis ones. The more advanced Finnish group has again done best, the reasons being clear: they have been listening to mistake-free utterances, and they have also been taught, at least to some extent, to recognize the differences from a native English speaker's speech. The less advanced group has made far more errors; this points to the conclusion that the teaching of pronunciation at university level has had some effect, at least as regards ability of perception. On the other hand, it seems to have had less effect as regards ability of pronunciation: the number of correct identifications of the English listener group is not very high, this, of course, being due to pronunciation mistakes made by the Finnish speakers.

The stop consonants in this position were examined only in the subminimal pair *east – eased*. The result from the English group is somewhat contrary to expectation. As has been noticed above, the Finnish speakers tend to make the vowel in *east* too long, and the /s/ too short. It was therefore expected that this longer vowel duration connected with the shorter duration of the /s/ would have been mistaken for the word *eased*, but the contrary took place: *eased* was mistaken for *east* in 50% of the cases. The more advanced Finnish group has cleared this hurdle without errors and the other Finnish group has also done fairly well.

What was said above does not apply to fricatives, however. The figures of group E in single fricatives are as expected: over half of the fortis fricatives have been identified incorrectly, this being due to the over-long vowels pronounced by the Finnish speakers in the words *loose, leaf*. The vowel duration is approximately the same in *lose, leave*, and here the results are much better. It is interesting that the /s/:s have been identified almost completely incorrectly, whereas three quarters of the /f/:s are correct. A possible explanation for this is that there is usually more voice in the final segment of *leave* than in that of *lose*, especially with Finnish speakers. /z/ seems to be the consonant most subject to devoicing in the final position, and it very easily becomes completely voiceless. The less advanced Finnish listeners have failed to interpret the differences of preceding vowel duration in the question of /s/ - /z/. With /f/ - /v/ the results are better, although half of the /v/:s are again wrong. Group *S2* have also failed rather badly to perceive that a longer vowel duration and shorter duration of the fricative must be interpreted as the lenis /z/ - only a little over one third of the identifications are correct. The /s/:s have been identified better, and the /f/:s 100% right in fact, but surprisingly many errors have been made in /v/. This may be due to the fact that the English speakers did not use as much voice in the word final /v/:s as the Finnish ones.

The last section of this test, word final /s/ and /z/ preceded by /n/, offers a number of interesting points. In identifying the word *since*, the mistakes made by the English listeners are very few. This is of course explained by the fact that the Finnish speakers pronounced the /n/ sufficiently short. The word *sins*, on the other hand, has without exception been identified as *since*, but this also has a simple explanation:

the /n/ in *sins* was not sufficiently lengthened by the Finnish speakers. The final /s/ was also made too short, and the /z/, in turn, too long. The only possible consequence of these pronunciation mistakes was that all the words were interpreted as *since*, with the fortis /s/ in the end. Group *S2* has succeeded very well in interpreting the different ration of sonorant and obstruent durations (long sonorant – short obstruent = /z/, and vice-versa = /s/). The other Finnish group is in intermediate position, this going to show that they have not really been aware of how these two words should be distinguished.

To summarize the results of the word tests, the word final position is the one where incorrect perception most frequently arises. In this position there are many points where Finnish speakers cannot even satisfactorily make the fortis – lenis distinction perceivable to an English-speaking listener. For Finnish listeners the problem is made easier, because they can listen to model pronunciations. Especially in connection with the word final lenis consonants, however, Finnish listeners often fail to make the right distinction. This must be due to the fact that the function of sound duration is here completely different from what it is usually in Finnish, and Finns cannot interpret these variations of sound durations correctly. The less advanced Finnish group especially is, in a way, "out on a limb" here, because they have received hardly any knowledge of these kinds of variations in vowel and consonant durations.

### 3.7. Sentence Tests

The perception test consisting of sentences was almost completely concentrated on consonants in the word final position: only two sentence pairs were chosen for the word initial and medial positions.

*Word initial consonants.* In the sentence pair chosen to represent the word initial position, the sounds under investigation were the somewhat disputed affricates /tr/ - /dr/. The percentages of correct identifications are presented below in Table 27.

Table 27. Percentages of correct identifications of the word initial affricates /tr/ and /dr/ in sentence tests.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| /tr/ | 79,2 | 70 | 73,3 |
| /dr/ | 95,8 | 66,7 | 73,3 |

The main feature carrying the distinction between /tr/ and /dr/ is the devoicing of the /r/ after /t/; the /r/ becomes a kind of voiceless fricative element, and this originally gave rise to these sounds being called affricates. Another distinctive feature is that /tr/ is usually longer than /dr/. However, it sometimes appears that the /r/ - element is partially devoiced after the lenis stop /d/ as well. If the difference of duration is not especially marked, the percentages of correct identifications can even be as low as they are in the table above. A comparison between the initial affricates /tʃ/ and /dʒ/ in word tests, and the present sounds, shows that the results in the sentence test are a little poorer, especially in group *S2*. However, the results are not directly comparable, because they are not exactly the same sounds in both tests. But this test again shows that even where we suppose it self-evident that the words will be identified correctly, our suppositions do not always hold good. The word final position is the most difficult one, but not the only one to cause problems.

The word medial consonants need not be dealt with here, because it was discovered that the word pair *decease – disease* is primarily distinguished by the duration of the stressed vowel, and thus it will be covered in connection with the test results on word final consonants.

*Word final consonants*. The perception test with most material was the sentence test on word final consonants. Two different sound groups will be covered below separately: first the single consonants, and then the consonant clusters restricted to sequences sonorant + obstruent. The results on single consonants are presented in Table 28.

Table 28. Percentages of correct identifications of word final single consonants in sentence tests.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| *All consonants tested* | | | |
| fortis | 77,3 | 74,8 | 84,2 |
| lenis | 68,6 | 68,8 | 77,9 |
| *Stops* | | | |
| fortis | 86,5 | 81,7 | 86,7 |
| lenis | 78,1 | 91,6 | 95,8 |
| /p/ | 70,8 | 80 | 70 |
| /b/ | 62,5 | 80 | 90 |
| /t/ | 91,7 | 81,7 | 95 |
| /d/ | 85,4 | 95 | 98,3 |
| /k/ | 87,5 | 83,3 | 86,7 |
| /g/ | 79,2 | 96,7 | 96,7 |
| *Fricatives* | | | |
| fortis | 65,3 | 84,4 | 88,9 |
| lenis | 66,7 | 42,2 | 63,3 |
| /s/ | 52,1 | 78,3 | 85 |
| /z/ | 60,4 | 43,3 | 66,7 |
| /f/ | 79,2 | 40 | 56,7 |
| *Affricates* | | | |
| /tʃ/ | 87,5 | 73,3 | 96,7 |
| /dʒ/ | 100 | 86,7 | 73,3 |

The more advanced Finnish group has again obtained the best results, while groups *S1* and E are fairly equal.

Fortis stops have been identified better than lenis ones by the English group, whereas the opposite is true of the Finnish groups. In the single pairs of stop consonants the same relation also obtains, with the exception of the /p/ - /b/ of group *S1*, where the percentages are equal. With fricatives, the relation of correct identifications is again opposite to that with stops: now the English subjects have identified lenis fricatives better, *S1* cannot identify even half of the lenis fricatives

correctly, and even S2's correct identifications only reach two thirds of the total at best. The results of the fortis fricatives are much better. Explanations for the identification errors are easy to find, and they are readily provided by the oscillograms in Fig. 17-18. The words *price* and *prize* pronounced by the Finnish informant are in fact completely equal; the only factor to distinguish these two words would be context of utterance. The same also applies to the stressed vowels and final consonants of the words *decease* and *disease*. As it seems that the most frequent mistake of vowel duration made by Finnish speakers is that of making tense vowels preceding fortis fricatives too long, the natural consequence of this is that fortis fricatives are more often identified as the corresponding lenis ones by English listeners. The difference in the tense vowel duration before lenis fricatives was not as marked between the groups, although the Finnish informants' vowels were here somewhat too short. This explains the reason for a greater proportion of the lenis fricatives being identified correctly, as /z/ or /v/. However, the correct identifications do not come to 100%, because the vowels are not lengthened sufficiently. Preceding fortis fricatives, the difference of vowel duration between the informant groups is greater, and more perception errors are consequently made. We have already noticed that, in connection with word final fricatives especially, the importance of the preceding vowel duration as a cue to the fortis – lenis distinction is very important; the lenis fricatives are often very strongly devoiced in word final position, especially /z/.

What, then, explains the fact that both Finnish listener groups have identified the fortis fricatives far better than the lenis ones? They have succeeded in recognizing the fairly short tense vowel duration as a cue for the fortis fricative (though not in all cases), but they have failed to pay attention to the considerably lengthened vowels preceding lenis fricatives, especially the less advanced group. Vowel length is known to be a very important distinctive feature in Finnish, but Finnish speakers are certainly not used to paying attention to vowel duration in this context. They do not expect tense vowels (traditionally "long") to be subject to considerable variation of length in different contexts, but expect them to be always about twice as long as the lax (traditionally "short") vowels, as in Finnish. Thus the "perception filter" of their mother tongue prevents

them from realizing the most important feature carrying the distinction. It is only natural that this perception filter is even stronger in group *S1*, which has not really received any systematic teaching of pronunciation. This is also reflected in the results: *S2* has identified lenis fricatives better than the less advanced group.

There is little to say about the affricates. The only case of 100% identification is found here; the Finnish informants have succeeded in making the distinction /tʃ/ - /dʒ/ well enough to be completely understandable. The majority of the Finnish informants have realized the distinction.

In connection with the fricatives, it was pointed out above that all the listener groups had special difficulties in identifying fricatives following tense vowels. Here, all the stressed vowels were tense ones. An opportunity is provided to compare the percentages of correct identifications when the preceding vowel is a diphthong in one category, and a lax vowel in the other. The final consonant in this case is a stop. The results are presented in the table below.

Table 29. Percentages of correct identifications of word final stops preceded by a diphthong or a lax vowel.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| *Diphthong* | | | |
| fortis | 81,3 | 83,3 | 85 |
| lenis | 68,8 | 85 | 95 |
| *Lax vowel* | | | |
| fortis | 91,7 | 80 | 88,3 |
| lenis | 87,5 | 98,3 | 98,3 |

Contrary to expectation, the above figures tell us next to nothing. About the only thing to be said is that stops preceded by a lax vowel are in general identified better than those preceded by a diphthong. But there is no reflection here of the difficulties in both production and perception that were found in the fricative section of Table 28, and in the phonetic analysis. It seems, after all, that one must still be very careful about making diphthongs directly comparable to tense vowels.

*Word final consonants preceded by another consonant.* Two different types must be distinguished here, on the basis of the nature of the preceding consonant. It can be an obstruent /s/ (or /z/) followed by the stops /t/ or /d/, or a sonorant /l/ (or/n/), followed /t/ or /d/, and /s/ or /z/, respectively. In Table 30, where the results of this test are shown, the consonants have been classified into two categories on the basis of the final consonant, i.e. into stops and fricatives. It is also possible, however, to make comparisons on how perception is affected by the nature of the preceding consonant. It also turned out that the most convenient way was to include the test words themselves in the table.

Table 30. Percentages of correct identifications of word final consonants preceded by another consonant.

| Speakers | Finnish S2 | English | English |
|---|---|---|---|
| Listeners | English | Finnish S1 | Finnish S2 |
| *Stops* | | | |
| fortis | 66,7 | 48,3 | 60 |
| lenis | 50 | 66,7 | 66,7 |
| *post* | 66,7 | 53,3 | 70 |
| *posed* | 33,3 | 66,7 | 73,3 |
| *built* | 66,7 | 43,3 | 50 |
| *build* | 33,3 | 73,3 | 96,7 |
| *Fricatives* | | | |
| *fence* | 87,5 | 73,8 | 96,7 |
| *fens* | 58,3 | 43,3 | 76,7 |

The number of correct identifications is here rather low; only a couple of percentages over 90% can be found, and the numbers of correct identifications vary from one third to two thirds approximately. In a comparison of the listener groups, *S2* is again in first place, its lowest figure being 50% correct.

The correct identifications of stops vary from 48,3% to 66,7% in fortis stops, and from 50% to 66,7% in lenis ones – almost identical figures. However, the words *post – posed* on the one hand, and *built* –

*build* on the other, are distinguished on completely different grounds. In the pair *post – posed*, both the duration of the diphthong and the intervening obstruent are affected by the fortis – lenis distinction: the diphthong especially is lengthened in *posed*. The intervening fricative element is longer in *post*; the difference was proved nonsignificant by the t-test (see Tables 10-11), although the oscillograms (cf. Fig. 15) clearly show that it is fairly marked. In this distinction, there are features that are among the most difficult for a Finnish speaker: tense vowel or diphthong preceding a fortis consonant, which is generally made too long, and a fortis fricative, which is generally made too short.

In the pair *built – build*, however, it is the intervening sonorant /l/ that is affected by the fortis-lenis distinction. It is considerably longer in *build*, whereas the /I/ is almost equal in duration to the /I/ in *built*. This is a third great difficulty for a Finnish speaker: he tends to make sonorant consonants before fortis obstruents too long.

The above difficulties in pronunciation are also reflected in perception. Groups E and S1 especially have had noticeable difficulties. The English listeners have identified the fortis stops better, which is a little surprising, knowing that Finnish speakers especially tend to pronounce vowels and sonorant consonants before fortis obstruents in the wrong way (i.e. too short). Both the Finnish groups have identified the lenis stops better, though in S2 the difference between fortis and lenis is very small in *post – posed*, but larger in *built – build*.

Finally, the fricatives preceded by /n/. First of all, the results of the test appear to be somewhat better than those of the stops. This can be at least partly explained by the fact that the test word pair *fence – fens* appeared in utterance final position, so that advantage could be taken of perception cues involved both with the preceding sounds and the consonants themselves. The stops appeared medially in the utterances, in a position where the stops themselves were amalgamated with the following sound, the fricative /ð/, so that they had to be identified almost solely on the basis of the preceding sounds.

The distinction of the pair *fence – fens* is in a way similar to *built – build*: the intervening sonorant, in this case /n/, is considerably longer in *fens*, i.e. preceding /z/. To this is added the variation of the duration of the final fricative: the /s/ in *fence* is considerably longer

than the /z/ in *fens*. These statements are supported by e.g. the oscillograms in Figure 13, where it can also be seen that the Finnish speaker has pronounced the two words almost as if they were the same. The result of this is that the English listeners have heard over 40% of the *fens* – utterances as *fence*. The case of the less advanced Finnish group is even worse – over 50% of the lenis utterances were heard as fortis. Generally, all the groups have here identified /s/ better than /z/.

The most prominent feature found in a comparison with the same consonant cluster in a word test is that the extreme cases (zero and 100% identifications) found in the word tests are completely lacking in the sentence tests.

## 4. SOME REMARKS ON THE TEACHING OF PRONUNCIATION

The results of the analyses and tests in the present work can be summed up briefly. Finnish learners can distinguish fairly well between fortis and lenis consonants when the properties carrying the distinction are in the consonants themselves: they realize the feature of aspiration in initial stops, and the voicing feature in word medial consonants. However, when the cues for the fortis – lenis distinction are also in the preceding sounds, difficulties emerge: the distinction shown to cause most difficulties for the Finnish learner is word final position. The reasons for these difficulties lie in teaching, or rather, in the lack of teaching.

The present writer has been working as a teacher of English at a Finnish comprehensive school for a number of years. During this time it has become clear that systematic teaching of pronunciation at school is virtually impossible today. There are two main reasons for this, the first being lack of time. The courses are so full of grammar and vocabulary that there is no time for the systematic teaching of pronunciation. In addition, the size of the groups are far too large, the largest containing up to 35 pupils. One class lasts 45 minutes, and if we take into account that the grammar and vocabulary involved in the text take up time (in fact most of the time), it is easy to see how little time remains for pronunciation. Individual pronunciation mistakes can be corrected, but little else can be done.

Another reason is that not even the teachers are always sufficiently competent in pronunciation. This can be seen in the results of the phonetic analysis and the perception tests, because most of the Finnish informants and listeners in group *S2* will become school teachers. There is much to be corrected, both in their pronunciation and perception. As university students with a cum laude course in English still make such mistakes, there must also be something wrong with the teaching of pronunciation at university. Here the teaching is systematic: pronunciation is a recognized subject in the study of English philology. But the greatest fault, at least when the present writer participated pronunciation courses, was that the courses and exercises almost solely concentrated on the production of sounds; perception and discrimination were almost completely neglected. This in spite of the fact that listening- and discrimination exercises have proved more useful in the teaching of pronunciation than repeated imitation exercises (see Lehtonen, 1972:40). The learner cannot realize his own mistakes and correct them, and repetition can thus even consolidate erroneous production. A pronunciation mistake always arises in perception: if the learner does not here the sound correctly, he will not be able to pronounce it correctly.

One further factor that makes adequate teaching of pronunciation difficult at schools especially is the lack of material and equipment. A teaching situation where the teacher would be able to listen to and correct the pronunciation of every individual pupil would require a well-equipped language laboratory of the AAC-type. This is, of course, beyond the reach of most schools. It is, however, also unnecessary. In experiments by Henning (see Lehtonen, 1972:40) it was proved that pupils who had gone through many discrimination exercises could pronounce better than those who had done imitation ecercises only: they could also realize their own mistakes better. Discrimination exercises could very easily be organized in a normal classroom with the help of a good tape recorder, but suitable tape material for school use is virtually non-existent today.

Finally, what is lacking in language teaching at schools today, is well expressed by Awedyk (1966:42): "The manuals of foreign languages should be bilateral and based on contrastive studies of the native tongue and the foreign language." When this stage is reached, we can find out the reasons for each individual pronunciation mistake and prevent it before it emerges, instead of trying to change the already acquired erroneous speech production.

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Appendix 1: The test material for the phonetic analysis.

Single words: killed/guild, seal/zeal, ripping/ribbing, breeches/bridges, rip/rib, shoot/should, hiss/his, trip/drip, east/eased, since/sins.

Word groups (the word in italics is the one examined):

beer - fraction - *team* - black - goose
break - sigh - *deem* - suck - go
extra - couple - *cheap* - get - give
truck - patron - *jeep* - throne - red
sun - water - *surfing* - hotel - beach
cloth - table - *serving* - glass - drink
trout - salmon - *cod* - perch
get - back - *caught* - see
care - go - say - *pick* - ask
cow - sheep - *pig* - duck
autumn - *leaf* - dark - cold
come - stay - *leave* - cry
thing - *loose* - bag - sing
gain - *lose* - travel - gamble
crime - *breach* - fire - earth
river - shore - *bridge* - cross

Sentences:

Did you remember to pay the pills/bills yesterday?
This is fine/vine, isn't it?
The lost sheep was bleating/bleeding in the snow.
The old man's decease/disease made everybody sad.
This rope/robe was too thin.
I couldn't hear the last bit/bid/beat.
He used to write/ride when he was young.
His back/bag was covered with writings.
I've never seen a real life/live peer.
What's the price/prize tonight?
This part of town is dominated by the rich/ridge.
We could hear something tripping/dripping down the stairs.
We post/posed the questions every Wednesday.
Those men built/build that house too carelessly.
The police chased the bandits over the fence/fens.

The words, word groups and sentences were read in *random order*.

Appendix 2: An example of the perception tests: the word test for English listeners (the words marked with + were removed from a word group).

1. since
2. breeches
3. leaf +
4. eased
5. cheap +
6. leave +
7. jeep +
8. lose +
9. deem +
10. bridges
11. team +
12. cheap +
13. deem +
14. lose +
15. sins
16. leaf +
17. loose +
18. east
19. breeches
20. eased
21. leave +
22. team +
23. loose +
24. eased
25. leave +
26. east
27. since
28. loose +
29. deem +
30. sins
31. jeep +
32. team +
33. bridges
34. cheap +
35. bridges
36. lose +
37. jeep +
38. sins
39. leaf +
40. east
41. breeches
42. since

The same words were included in the word test for Finnish listeners, but in a different order. Each item was heard *twice*.

Appendix 3: An example of the perception tests: the sentence test for Finnish listeners.

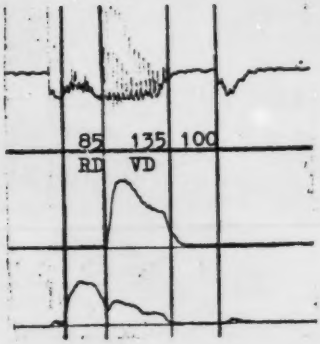
1. Those men build that house too carelessly.
2. The old man's disease made everybody sad.
3. This rope was too thin.
4. We posed the questions every Wednesday.
5. This part of town is dominated by the rich.
6. We could hear something dripping down the stairs.
7. What's the price tonight?
8. We could hear something tripping down the stairs.
9. This part of town is dominated by the ridge.
10. I couldn't hear the last bit.
11. The police chased the bandits over the fence.
12. I couldn't hear the last bid.
13. I've never seen a real live peer.
14. He used to write when he was young.
15. The police chased the bandit over the fens.
16. His bag was covered with writings.
17. His back was covered with writings.
18. He used to ride when he was young.
19. The police chased the bandits over the fens.
20. I've never seen a real life peer.

21. His bag was covered with writings.
22. He used to ride when he was young.
23. This robe was too thin.
24. I've never seen a real live peer.
25. We could hear something dripping down the stairs.
26. What's the prize tonight?
27. I couldn't hear the last bit.
28. This part of town is dominated by the ridge.
29. We post the questions every Wednesday.
30. What's the price tonight?
31. I couldn't hear the last bid.
32. Those men built that house too carelessly.
33. We posed the questions every Wednesday.
34. This rope was too thin.
35. The old man's decease made everybody sad.
36. Those men build that house too carelessly.
37. The old man's disease made everybody sad.
38. Those men build that house too carelessly.
39. Those men built that house too carelessly.
40. This part of town is dominated by the rich.
41. We posed the questions every Wednesday.
42. We could hear something tripping down the stairs.
43. What's the price tonight?
44. The old man's decease made everybody sad.
45. We post the questions every Wednesday.
46. The police chased the bandits over the fence.
47. I couldn't hear the last bit.
48. What's the prize tonight?
49. He used to write when he was young.
50. I've never seen a real live peer.
51. This robe was too thin.
52. His back was covered with writings.
53. His bag was covered with writings.
54. I've never seen a real life peer.
55. This robe was too thin.
56. He used to ride when he was young.
57. His back was covered with writings.
58. I've never seen a real life peer.
59. The police chased the bandits over the fens.
60. He used to write when he was young.
61. What's the prize tonight?
62. We could hear something dripping down the stairs.
63. The police chased the bandits over the fence.
64. We post the questions every Wednesday.
65. This part of town is dominated by the ridge.
66. We could hear something tripping down the stairs.
67. Those men built that house too carelessly.
68. I couldn't hear the last bid.
69. This part of town is dominated by the rich.
70. The old man's decease made everybody sad.
71. This rope was too thin.
72. The old man's disease made everybody sad.

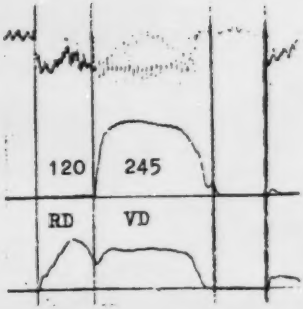
The same sentences were included in the sentence test for English listeners, but in a different order. Each item was heard *twice*.

Appendix 4. Figures 1-18. Sample oscillograms and spectrograms of segmentations of individual words as pronounced by native and Finnish speakers.

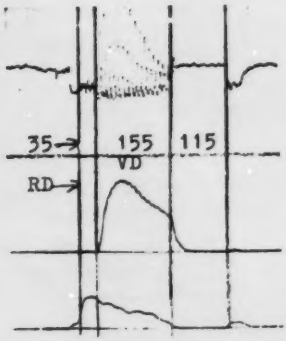
Figure 1. Word initial affricates
RD = release duration (msec)
VD = vowel duration (msec)



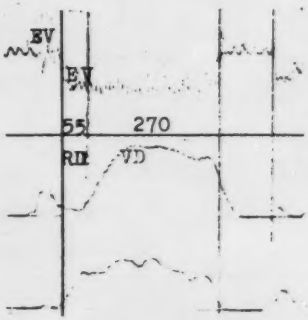

*cheap*
(English speaker)




*cheap*
(Finnish speaker)

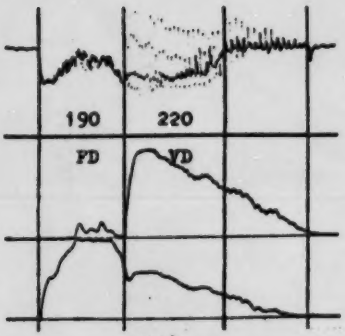



*jeep*
(English speaker)

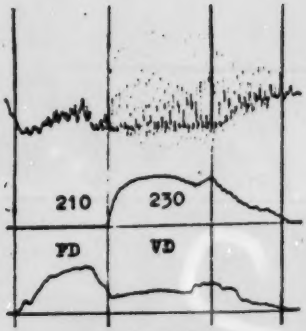



*jeep*
(Finnish speaker)

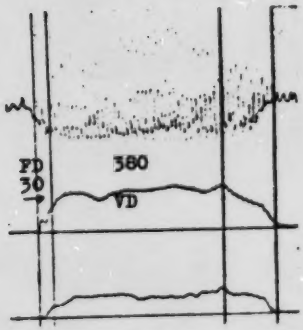
Figure 2. Word initial fricatives.
FD = friction duration (msec)
VD = vowel duration (msec)



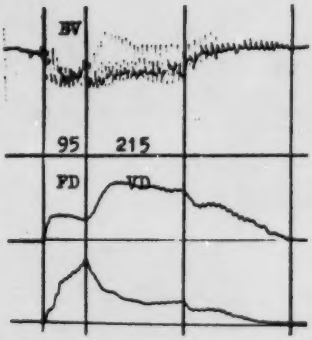

*szal*
(English speaker)




*seal*
(Finnish speaker)

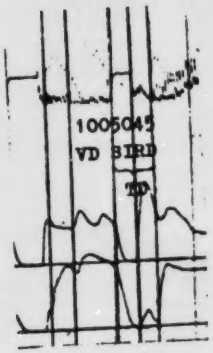



*zeal*
(English speaker)

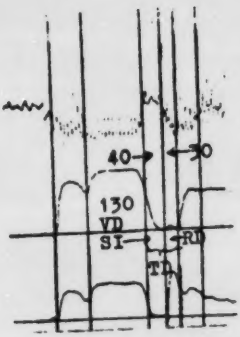



*zeal*
(Finnish speaker)

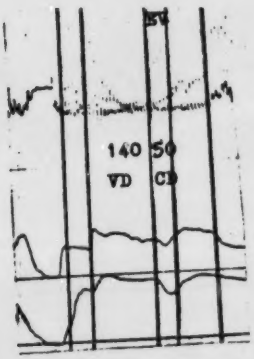
Figure 3. Word medial stops.
VD = vowel duration (msec)
SI = silent interval (msec)
RD = release duration (msec)
TD = total duration (msec)



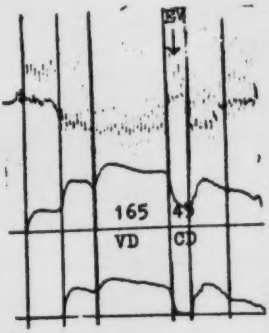

*bleating*
(English speaker)




*bleating*
(Finnish speaker)

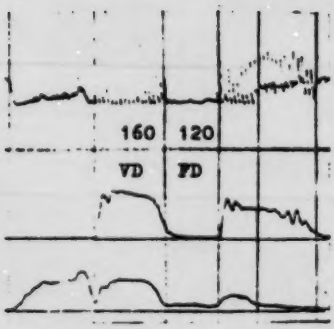



*bleeding*
(English speaker)

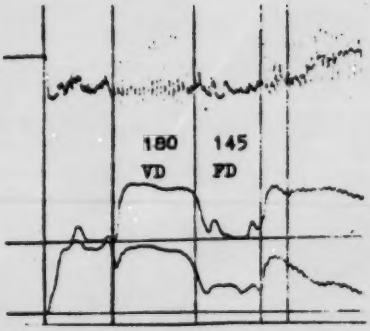



*bleeding*
(Finnish speaker)

Figure 4. Word medial fricatives.
VD = vowel duration (msec)
FD = friction duration (msec)




*surfing*
(English speaker)

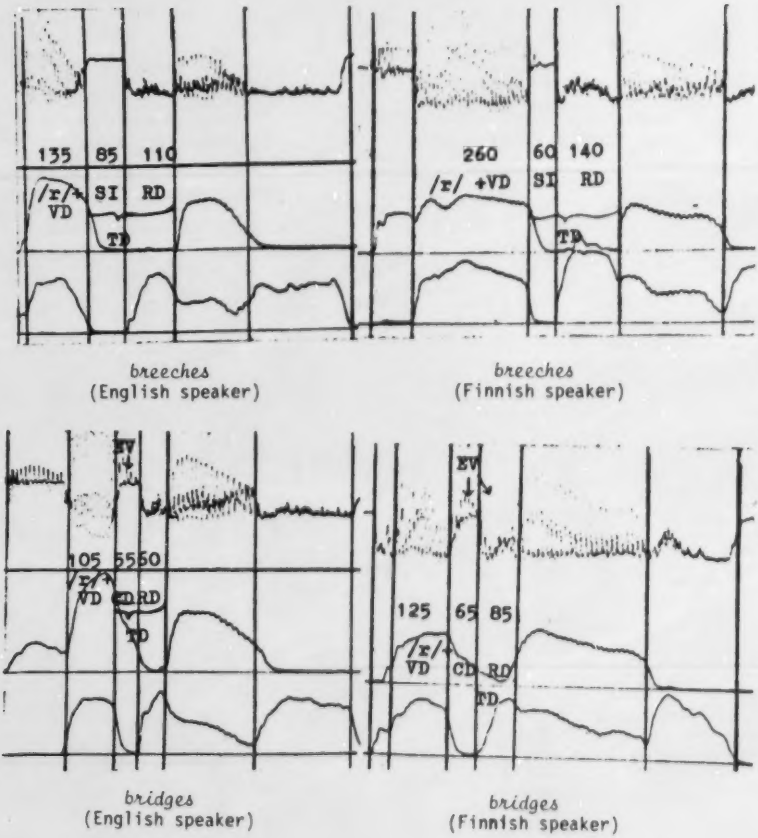



*surfing*
(Finnish speaker)

*serving*
(English speaker)

*serving*
(Finnish speaker)

Figure 5. Word medial affricates.
VD = vowel duration (msec)
SI = silent interval (msec)
RD = release duration (msec)
TD = total duration (msec)
EV = extent of voicing (msec)




*breeches* (English speaker)

*breeches* (Finnish speaker)

*bridges* (English speaker)

*bridges* (Finnish speaker)

Figure 6. Word final stops.
VD = vowel duration (msec)
SI = silent interval (msec)
EV = extent of voicing (msec)
CD = consonant duration (msec)

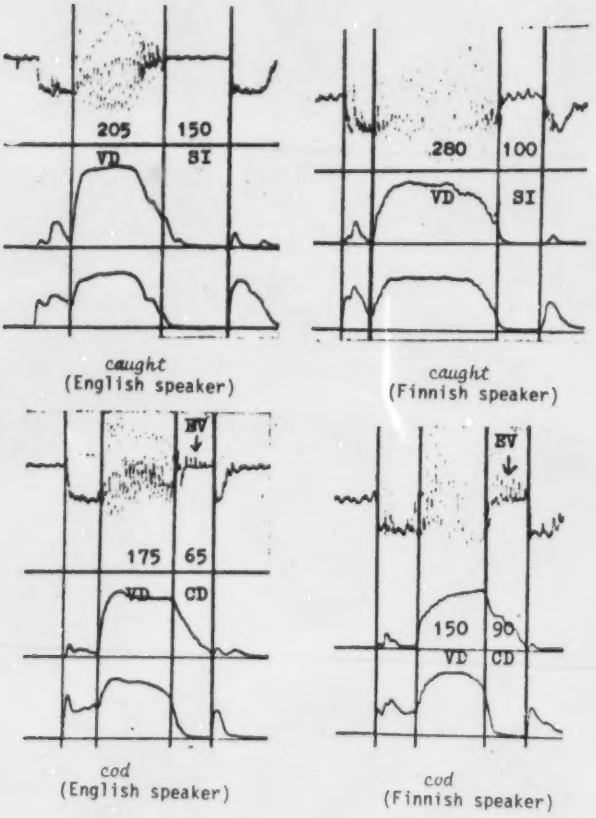
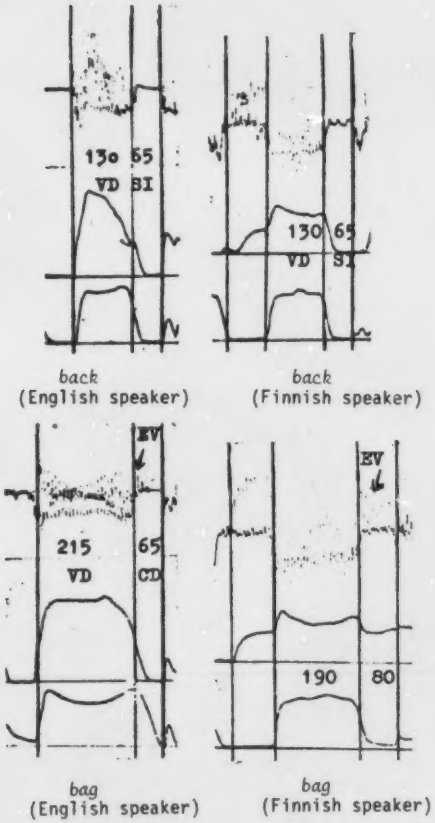


Figure 7. Word final stops.
VD = vowel duration (msec)
SI = silent interval (msec)
EV = extent of voicing (msec)
CD = consonant duration (msec)



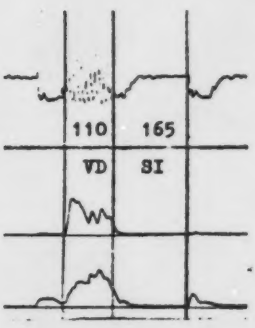

*back* (English speaker)

*back* (Finnish speaker)

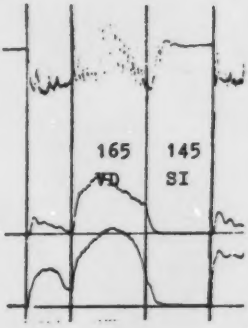
*bag* (English speaker)

*bag* (Finnish speaker)

Figure 8. Word final stops (msec)
VD = vowel duration (msec)
SI = silent interval (msec)
CD = consonant duration (msec)
EV = extent of voicing (msec)

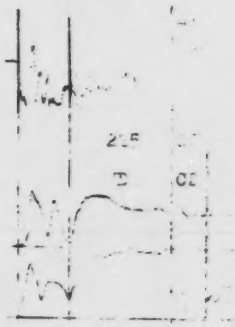



*pluck*
(English speaker)



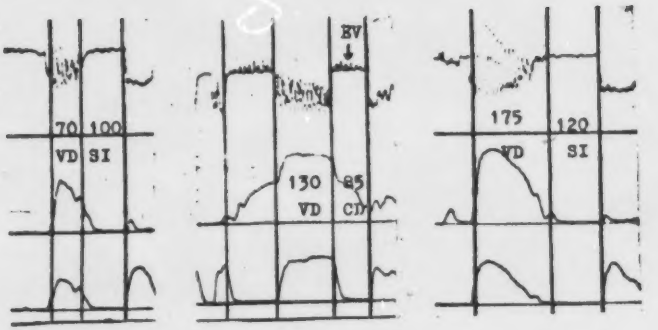

*pluck*
(Finnish speaker)

*plug*
(English speaker)

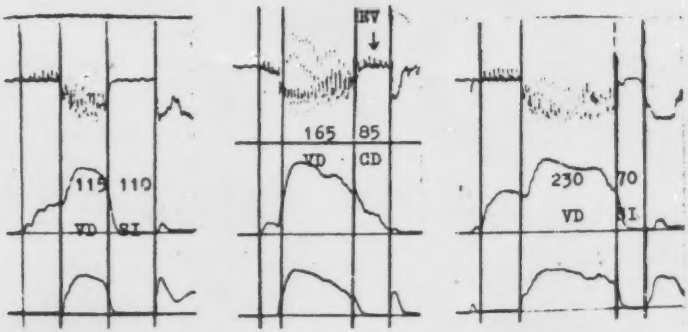


*plug*
(Finnish speaker)

Figure 9. Word final stops.
VD = vowel duration (msec)
SI = silent interval (msec)
EV = extent of voicing (msec)
CD = consonant duration (msec)




*bit* (English speaker) *bid* (English speaker) *beat* (English speaker)




*bit* (Finnish speaker) *bid* (Finnish speaker) *beat* (Finnish speaker)

Figure 10. Word final affricates.
VD = vowel duration (msec)
SI = silent interval (msec)
RD = release duration (msec)
TD = total duration (msec)
CD = consonant duration (msec)
EV = extent of voicing (msec)

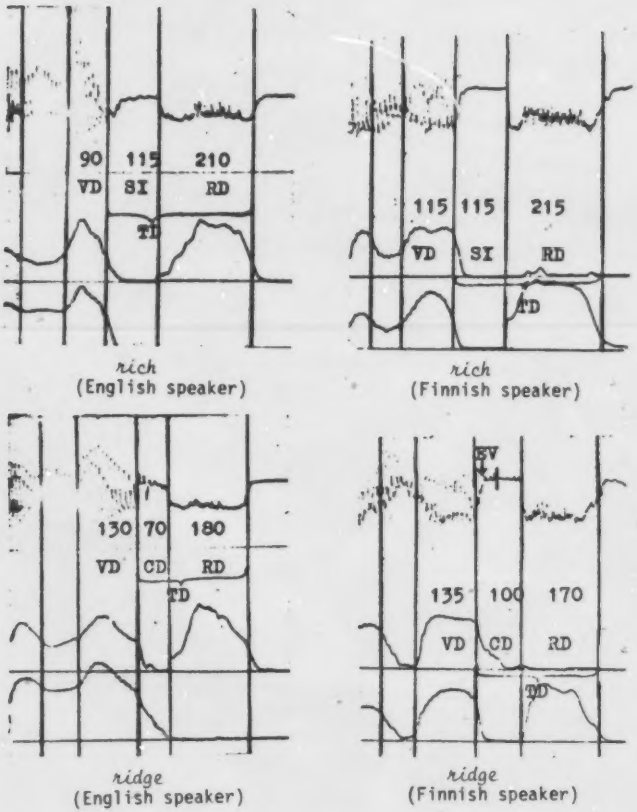
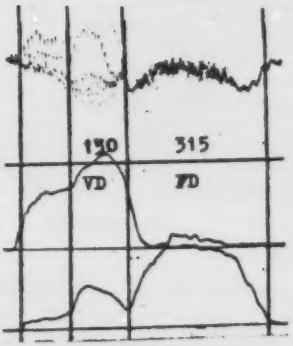
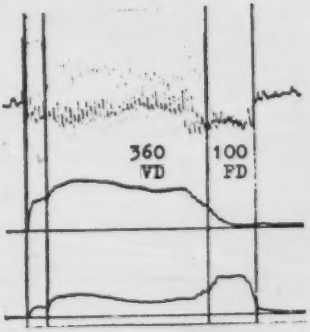


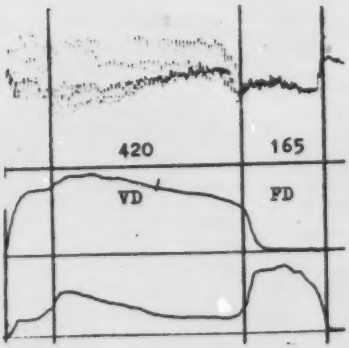
Figure 11. Word final fricatives.
VD = vowel duration (msec)
FD = friction duration (msec)



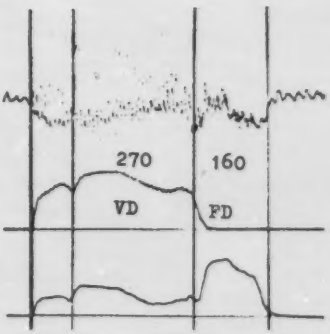

*loose*
(English speaker)




*loose*
(Finnish speaker)

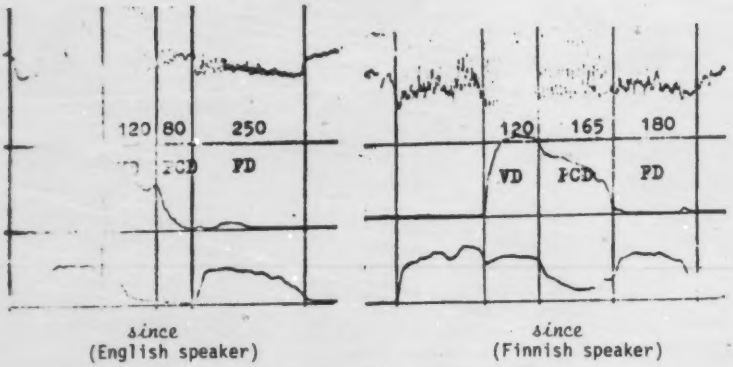



*lose*
(English speaker)

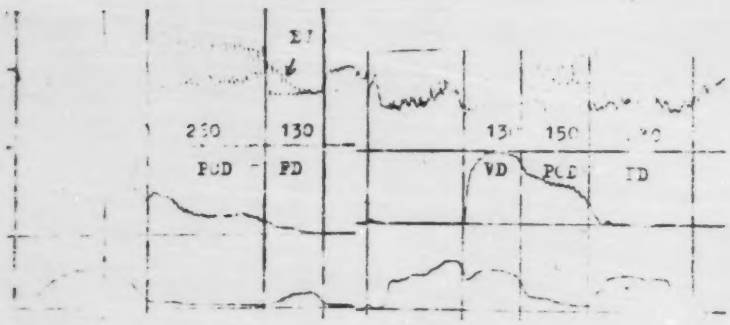



*lose*
(Finnish speaker)

Figure 12. Word final fricatives.
VD = vowel duration (msec)
PCD = duration of the consonant preceding a word final consonant (msec)
FD = friction duration (msec)




*since* (English speaker) *since* (Finnish speaker)




*sins* (English speaker) *sins* (Finnish speaker)

Figure 13. Word final fricatives.
VD = vowel duration (msec)
PCD = duration of the consonant preceding a word final consonant (msec)
FD = friction duration (msec)

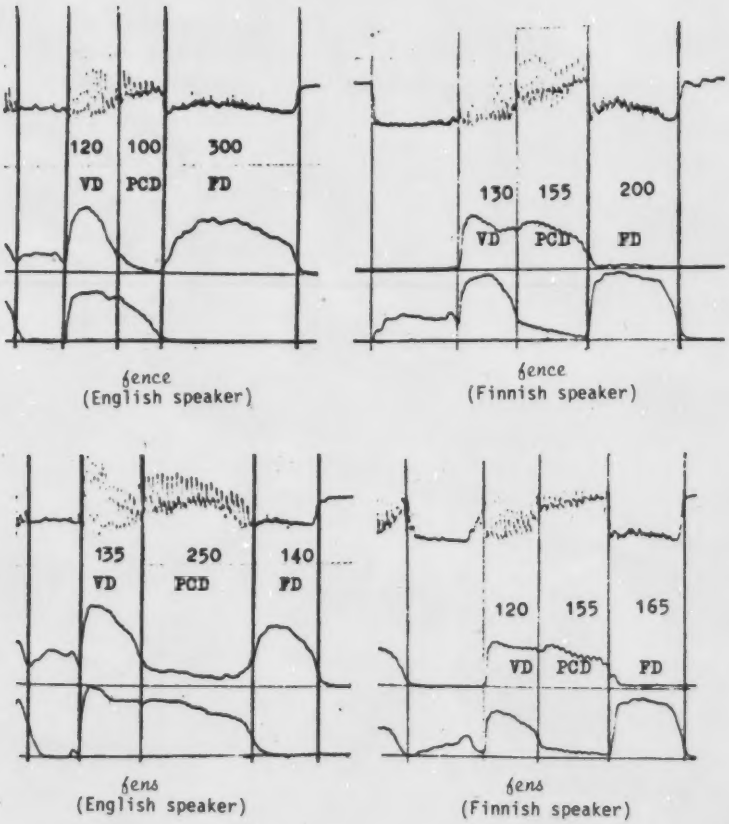
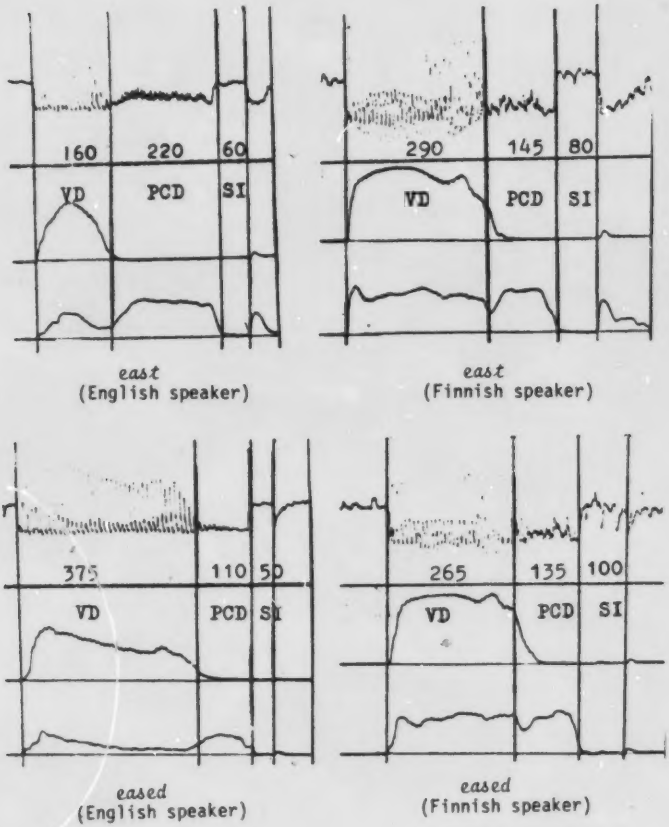


Figure 14. Word final stops.
VD = vowel duration (msec)
PCD = duration of the consonant preceding a word final consonant (msec)
SI = silent interval (msec)



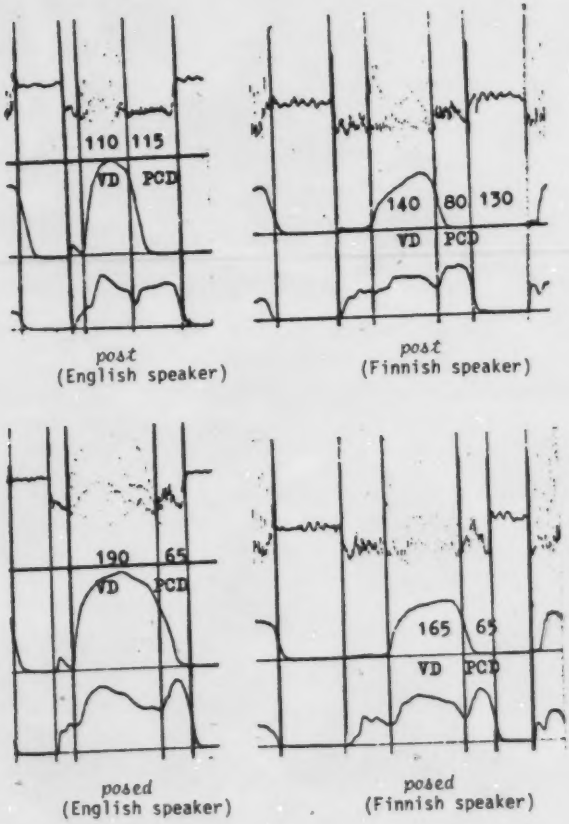

*east*
(English speaker)

*east*
(Finnish speaker)

*eased*
(English speaker)

*eased*
(Finnish speaker)

Figure 15. Word final stops.
VD = vowel duration (msec)
PCD = duration of the consonant preceding a word final consonant (msec)



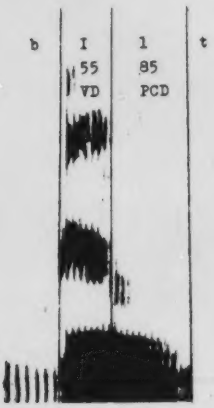

*post* (English speaker)

*post* (Finnish speaker)

*posed* (English speaker)

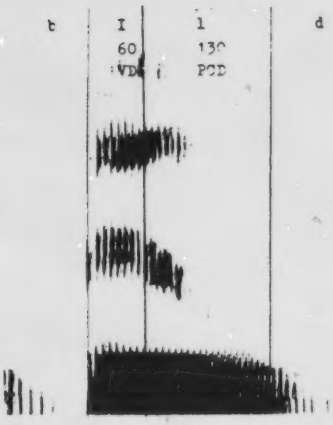
*posed* (Finnish speaker)

Figure 16. Word final stops.
VD = vowel duration (msec)
PCD = duration of the consonant preceding a word final consonant (msec)

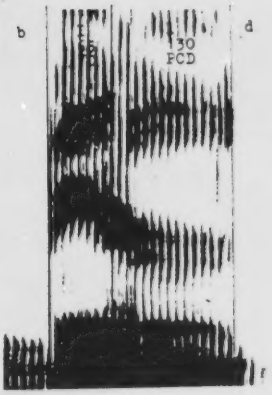



*built*
(English speaker)

*built*
(Finnish speaker)




*build*
English speaker)




*build*
(Finnish speaker)

Figure 17. Word final fricatives.
VD = vowel duration (msec)
FD = friction duration (msec)

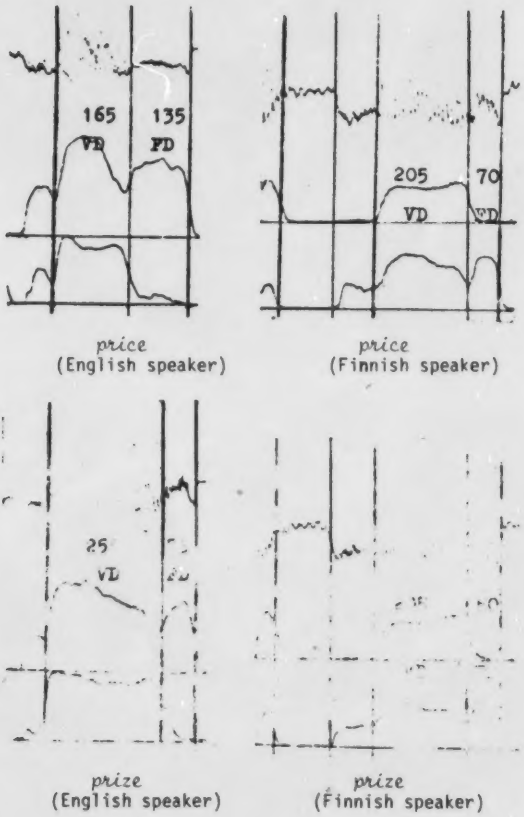
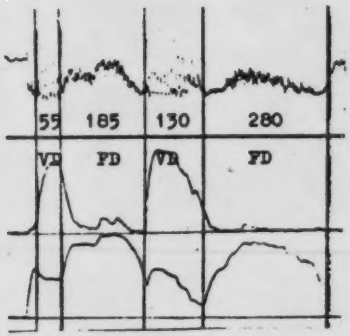
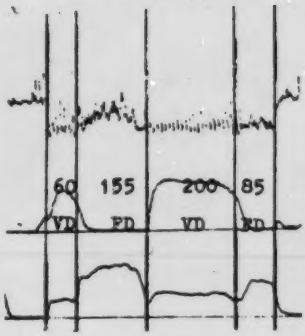


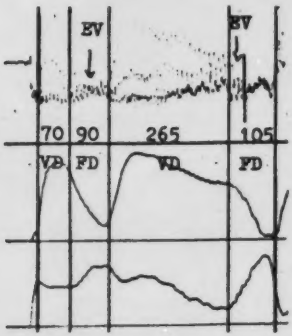
Figure 18. Word final fricatives.
VD = vowel duration (msec)
FD = friction duration (msec)
EV = extent of voicing (msec)



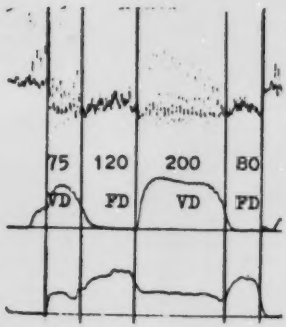

*decease*
(English speaker)




*decease*
(Finnish speaker)




*disease*
(English speaker)




*disease*
(Finnish speaker)

# THE DISCRIMINATION AND IDENTIFICATION OF ENGLISH VOWELS, CONSONANTS, JUNCTURES AND SENTENCE STRESS BY FINNISH COMPREHENSIVE SCHOOL PUPILS

REIJO LAMMINMÄKI
*University of Jyväskylä*

## INTRODUCTION

This study is an attempt to map the factors which influence the perception of English vowels, consonants, junctures and sentence stress by Finnish comprehensive school pupils. It is a shortened version of a report (a pro gradu thesis) which is part of the Finnish-English Contrastive Project at the English Department of the University of Jyväskylä. The original report contains a more profound discussion of the background and a more detailed presentation of the results. Many problems similar to those dealt with in this study have been examined before. For example, many perceptual problems caused by English vowels and consonants for Finns learning English have been traced back to the phonetic identification cues. The evidence has, however, mainly come from word level studies. The present study attempts to map the relevance of these and other cues at the sentence level.

## THE AIM OF THE STUDY

This study is concerned with the difficulties encountered by Finnish comprehensive school pupils in learning English receptive pronunciation skills. Because of the many-sided nature of the receptive skills, the study has been focused on the potential sources of difficulty caused by certain phenomena belonging to English phonology such as they appear in the network of understanding sentences. The material of the study consists of minimal (phonological) oppositions (eg. /i/ - /ɪ/, /k/ - /g/) at both segmental and suprasegmental level. The oppositions occur in sentences like *His bid is too high/His bed is too high*, ie. the sentences form pairs.

The reception difficulties of this kind of material are studied by means of two different perceptual tests: the discrimination test and the identification test. By means of the test results and by using certain background variables (like the mastering of the vocabulary of the

identification test items and the school marks in different subjects) an attempt is made to answer the following questions:

(1) How are the manifestations of the phonological distinctions used in this study discriminated and identified?

(2) What factors influence the particular discrimination and identification results, ie. the receptive process dealt with in this study? What are the causes of the difficulties in the reception of the phonological oppositions tested?

(3) What do the discrimination and identification tests measure? Is the mastering of the productive skills predictable by the discrimination and/or identification test results?

## THE METHOD OF THE STUDY

*The material of the study.* - From the point of view of studying the perceptual process, natural speech (ie. conversation) would be ideal material. The use of this kind of material is not, however, possible for various reasons (see Lehtonen 1977: 39) and therefore minimal pair technique was adopted. Natural speech was approximated by using complete sentences instead of individual words. In order to be comprehensive enough the material consists of both segmental (ie. vowels and consonants) and suprasegmental (junctures and sentence stress) aspects of the English phonological system. The study is based on the use of minimal phonological oppositions that are mostly contrastively (Finnish - English) selected, ie. oppositions found difficult for Finnish learners of English in previous studies are included in the material. This is especially true of the segmental items whereas the choice of the suprasegmental material cannot be made by such means because empirical contrastive knowledge of the suprasegmental phenomena is scanty.

The occurrence of the minimal oppositions in sentences causes a certain amount of selectiveness and also places some restrictions on the choice of the material. Firstly, the insertion of one opposition member into an identical sentence frame with its counterpart eliminates the use of certain oppositions completely; it is difficult to find any sentence frame for many oppositions. For example, the insertion of the word pairs *leaf - leave* and *white shoes - why choose* into an identical sentence frame is impossible because the grammatical functions of the members of both pairs are different. Secondly, the material should not be too difficult for Finnish comprehensive school pupils to cope with. Thirdly, the

occurrence of the phonological items studied varies both in regard to their position in a word and in an utterance. On the whole the choice of the material is a compromise between suitable sentence frames and contrastive criteria of difficulty.

The selection of the *vowels* was mainly based on Wiik's (1965) contrastive phonetic study of Finnish and English vowels. Wiik (1965: 59) analysed the formant structures of all the Finnish and English vowels by sound wave analysis. By comparing the phonetic distribution areas of Finnish and English vowels and by looking at the results of the substitution tests administered by Wiik (1965: 64, 67, 77-78, 80) certain English vowels could be specified as probable sources of difficulties of of perception (identification and discrimination) for Finnish learners of English. Perceptual difficulties can often be expected when the phonetic distribution area of an English vowel correlates with two different Finnish vowels.

The present study concentrated on English tense-lax oppositions because the perception of these oppositions seems to be especially troublesome for Finnish learners. However, the opposition /ʌ/ - /a/ has been included and /ʊ/ - /u:/ has been disregarded. The vowel oppositions which were selected are presented in Table 1.

Table 1. Vowel oppositions and the number of times they are tested in this study

| Opposition tested | Times tested |
|---|---|
| /i:/ - /ɪ/ | 4 |
| /ɪ/ - /e/ | 4 |
| /ɔ/ - /ɔ:/ | 3 |
| /ʌ/ - /ɔ/ | 4 |
| /ʌ/ - /a/ | 3 |
| Total | 18 |

The Finnish and English *consonant systems* differ from each other in at least two respects: (1) The number of English consonant phonemes is nearly double the number of Finnish ones. (2) The English system has a distinction not existing in Finnish, ie. fortes-lenes. The number of fricatives is also clearly greater in English (11) than in Finnish (2) (Lehtonen, Sajavaara and May 1977: 128). The greatest number of learning

problems seem to be centred round the English fricatives and fortes-lenes oppositions (Moisio and Valento 1976: 49-53). Accordingly, the consonants selected for this study are fricatives and fortes-lenes oppositions. Table 2 presents the distinctions studied.

Table 2. Consonant oppositions and the number of times they are tested in this study

| Opposition tested | Times tested |
|---|---|
| /p / - /b / | 3 |
| /t / - /d / | 4 |
| /k / - /g / | 4 |
| /tʃ/ - /dʒ/ | 3 |
| /tr/ - /dr/ | 2 |
| /s / - /θ / | 2 |
| /ʃ / - /tʂ/ | 2 |
| /tʃ/ - /dz/ | 1 |
| Total | 21 |

*Juncture* is not a discrete concept, as vowels and consonants are, because it is connected with a larger part of an utterance. A common definition for juncture is that it is a "non-phonemic modification of sounds at certain grammatical boundaries" (Lehiste 1960: 9, Hoard 1966: 106), ie. the grammatical boundaries of language structures can modify sounds; if modifiable sounds happen to occur at such boundaries, junctures are present and observable, but if no such sounds are present, junctures are not phonetically perceptible. Thus junctures are bundles of identification cues in phonetic surface representation and the cues are conditioned by higher level language structures.

In some cases, the segmentation of the same sequence of phonemes into units in two different ways changes the meaning of the sequence, which means that juncture is responsible - at least on an abstract level of phonology - for the phonological distinction in question. This distinction need not, however, be phonetically present. The juncture material consists of 13 pairs of sentences.

The function of the *sentence stress* is to make certain parts of an utterance prominent and, in this way, to influence the semantic content

of the message. The shifting of the stress within an utterance may cause more or less profound changes in the meaning. An example is *'Flying aeroplanes can be dangerous/ Flying 'aeroplanes can be dangerous*. The sentence stress material of this study consists of 8 pairs of sentences.

*The tests used.* - The aim of the *discrimination test* was to find out how the subjects can, in their auditory perception, perceive the members of the minimal opposition pairs as distinct from each other. The testees heard sequences of three sentences from the tape. One sentence was different from the other two in regard to the characteristics maintaining the minimal opposition in question. The subjects' task was to find out which of the three sentences was different. They had six seconds to judge each sequence. The two similar sentences in the sequences were exactly the same, because one and the same recording had been used in both cases. The whole test lasted about 32 minutes, so that each active listening period was about four and a half minutes long.

In the test instruction the subjects were told to concentrate on listening to the phonetic cues and to pay no attention to the meanings of the sentences. The reliability coefficient of the test was 0.66, which is not particularly high. One reason for this is to be found in the way the reliability coefficient was calculated (the split-half method). Because the standard deviation of the test was quite low (5.02) (see Appendix 2) and the range of the scores was from only 30 to 49 (the theoretical range being 0 - 60), the correlation coefficient of the test halves remained quite low (for the factors influencing the correlation coefficient see eg. McNemar 1966: 187 or Magnusson 1969: 93). One reason for the low standard deviation is that the subjects were able to reach nearly the same performance level in this test. This is also why the discriminatory power of the test is not very strong. The solution percentage was 64.4 %, which lies between the 30 % and 70 % recommended by Takala (1975: 175).

The aim of the *identification test* was to study the identification of phonological oppositions in sentences. The subjects had to pick up the identification cues of the oppositions occurring in sentences and use these cues in the understanding of the sentences. The material consisted of the same minimal sentence pairs as the discrimination test. The subjects heard the sentences containing the oppositions from a tape twice. They were expected to understand the meaning of the sentence by translating it into Finnish. On an answer sheet they found

multiple choice alternatives (three in each case). The alternatives were given in Finnish, one of them being the correct one, the other two being the opposite member of the right alternative and a distractor. The following is an example:

4. A. Näin laivan siellä *'I saw the ship there'*
   B. Näin perunalastun siellä *'I saw the chip there'*
   C. Näin lampaat siellä *'I saw the sheep there'*

The time allowed for answering was 15 seconds.

The greatest problem related to the planning of this test is the introduction of good multiple choice alternatives. The reliability coefficient of the identification test (0.68) nearly corresponds to that of the discrimination test. Partly, this may be due to the weakness of a few distractors. The main reason, however, seems to be that all the testees had not completely mastered the words in which the structures tested occur. Therefore the identification percentages of the test items vary and cause some inconsistency in the test scores.

The discriminatory power of this test is somewhat stronger than that of the discrimination test. The standard deviation of the test scores is considerable (11.51) and the range of the scores with one exception fluctuates between 47 and 97 (the theoretical range being 0 - 120). The solution percentage (51.5 %) is quite near to the ideal (see Appendix 2).

The aim of the *vocabulary test* was to find out how well the key words in the identification test (ie. the words containing the structures tested) were mastered. In this way it was possible to find out what effect the mastering of the key words had on the identification test results for each particular test item. The method used was a multiple choice test in which the subjets chose a Finnish equivalent for an English key word from four alternatives. No reliability coefficient was calculated, because the purpose of the test was not to measure the mastering of vocabulary but to map the familiarity of certain words having a central role in the identification test.

The aim of the *production test* was to measure the subjects' productive skills (ie. the standard of these skills). The purpose was to set up a productive counterpart for the perception tests (discrimination, identification) used in this study to establish a correlation between the receptive and productive skills. The linguistic material was the same as used in the perceptual tests. The subjects read the sentences typed on cards onto the tape. The evaluation of the testees' productions was carried out by three

native informants. All of them were experienced in this kind of task. The informants first listened to a short sample of each testee's pronunciation to get a general idea of the subject's production skills. Then they heard a one-minute sample of each subject's pronunciation and evaluated the sample on a five point scale: *very good - good - fair - bad - very bad*. The evaluation was to be based on the general standard of pronunciation (including both segmental and prosodic phenomena).

The evaluations by the different informants corresponded to each other quite well. In only four cases was the difference between the evaluation scores two points. The means of the informants' evaluations do no differ very much either. The intercorrelation calculated between the three evaluations is 0.76.

The evaluation took place in the laboratory of the Phonetics Department of the University of Jyväskylä and hifi equipment was used for the listening. The listening tests were done in the same laboratory . The material for the study was recorded by an English informant.

The tests were administered at Töysän peruskoulu in May 1975. The time allowed for them was two days. The listening tests were administered in the morning of the first day divided into the following phases: discrimination test - break - the first half of the identification test - break - the second half of the identification test. The vocabulary test was given after the listening tests and the rest of the day and the whole of the second day were used for the recording of the testees' productions. The listening tests were held in the usual kind of classroom. Because the use of the headphones was not possible the listening test was carried out using loudspeakers. The technical equipment exceeded the norms defined for this purpose (see eg. Lehtonen 1972b: 4-5); a Tandberg 12 SL tape recorder (output volume 10 watts) was used as an amplifier together with a Philips 851 radio (output volume 14 watts), the loudspeakers (three altogether) exceeded the 12 w output volume and the tape speed was 9.5 cm/sec. In general the acoustics of the classroom were quite good.

*The informants.* - The informants for the study were four native English speakers (one of them pronounced the test sentences and three of them evaluated the comprehensive school pupils' pronunciation standard) and 25 Finnish comprehensive school pupils (as subjects in the perceptual tests). The choice of the person who read the test material onto the tape was a compromise. The aim was to find a person with a pronunciation as 'neutral' as possible because it was probable that the pupils were not

sufficiently acquainted with different regional or social varieties of English. It was clear that whoever the 'pronouncer' was, his speech would always contain certain peculiar features of its own. In addition, he could be expected to change his pronunciation according to social or regional dimensions depending on the situation in question (Corder 1973: 55, Labov 1970: 188-190). The suitable speaker was found by leaving out R.P. pronunciation and the clearest regional varieties (American, Scottish and Welsh varieties of English). Because the number of the English native speakers available was limited, the choice of the informant did not cause great difficulties. All the native English informants were lecturers at the English Department of the University of Jyväskylä.

The Finnish subjects were pupils from the 9th grade. They had studied English for six years and Swedish for three years. All the levels of elaboration (ie. the general, the middle and the advanced courses) were represented. The number of the pupils chosen from every course level was proportional to the general division of the pupils to these course levels (see POPS opas 3b 1970: 9); the advanced (6 pupils) and general (3 pupils) courses had smaller representation than the middle course (16 pupils).

RESULTS

In this report the results of the study will be limited to the review of how each type of opposition (eg. /ɪ/ - /i/, /p/ - /b/) was perceived. All the opposition pairs tested will be analysed separately, because all seem to have several peculiar features of their own. All the test results are in Appendix 4. Only the words containing the structures tested are given (test sentences in their entirety are found in Appendix 1).

The second main section of the analysis deals with the pragmalinguistic explanations for the perceptual test results, and the third main section with the relevance of the results for the testing of pronunciation. Special emphasis will be laid on the possibility of predicting the standard of the productive skills on the basis of the perceptual test results.

*Vowel oppositions - Opposition* /ɪ/ - /*i*:/. - The English opposition /I / - /i:/ can be expected to cause discrimination and identification problems for Finns learning English, because no corresponding opposition occurs in Finnish. Wiik's (1965: 59) analysis shows that the variants of English /I / are close to the phonemic boundary of Finnish /i/ and

/e/, ie. the relational difference between the two languages prevails (Wiik 1965: 21). The variants of English /i:/ are completely within the phonemic area of Finnish /i/. Therefore we may assume that the allophones of English /i:/ will cause no perceptual problems, ie. positive transfer is possible. Actually, the allophones of English /ɪ/ can be replaced either by Finnish /i/ or /e/. which results in undifferentiation. This implies that major problems of identification centre round the /ɪ/ member of the opposition, and accordingly, the identification test should show higher scores for the allophones of /i:/ than for those of /ɪ/.

To find out which of the opposition members, /i:/ or /ɪ/, is more difficult, the mean standard deviation and mean percentage has been calculated for the /i:/ and /ɪ/ identifications separately. The results are presented in Table 3. The t-value (1.3596) calculated between the means of /i:/ and /ɪ/ (16.3) does not exceed the critical value of the 5 % risk level (= 2.064). Thus the difference between the means is not statistically significant. This means that both opposition members are equally well identified and no general trend favouring one or the other member of the opposition was found ie. the contrastive hypothesis does not get support in the case of the /i:/ - /ɪ/ opposition.

Table 3. The identification of the allophones of the opposition /i:/ - /ɪ/.

| Vowel tested | Times tested | Mean | stdev | % | t-value | significance |
|---|---|---|---|---|---|---|
| /i:/ | 4 | 14 | 5.94 | 56 | 1.3596 | |
| /ɪ/ | 4 | 16.3 | 5.74 | 65 | 1.3596 | none |

The sound system cues are not powerful enough in all cases to direct identification. Instead, many pragmatic factors (like the mastering of the vocabulary of the test sentences or the confusion of certain tenses as well as some orthographical and idiolectal features) have very strongly contributed to the uniform identification result; sometimes the pragmatic cues favour one member and sometimes the other member of the opposition in question.

The discrimination percentages of the pair /i:/ - /ɪ/ range from 88 % to 64 %, the mean being 76 %, so that all the informants have not "heard" the distinction. The highest percentage seems to be attributable

to the sentence final position of the opposition (*leave - live*). The informants seem to have discriminated on the basis of the durational difference which they have learnt in Finnish[1]. A Finn utilizes durational differences mainly in differentiating between English tense and lax vowels; in production a Finn also often substitutes the Finnish double vowel for the English tense vowel and the Finnish single vowel for the English lax vowel (Lehtonen, Sajavaara and May 1977: 100). Because the duration of a Finnish double sound is approximately twice of the duration of a single sound and the duration of a English tense vowel is about 1.5 to 2 times the duration of a lax one, the use of quantity as a cue in this pair *live - leave* is quite possible, although the durations are subject to extensive variations.

*Opposition* /ɪ/ - /e/. - The contrastive problems caused by the English opposition /ɪ/ - /e/ are similar to those of /ɪ/ - /i:/. The allophones of /ɪ/ should cause difficulties. The variants of /e/ are within the phonemic area of Finnish /e/, with the exception of /e/ followed by [t], but there the confusion is more often between /ɛ/ and /e/ than between /ɪ/ and /e/ (Wiik 1965: 59). Thus we can expect higher scores for /e/ than for /ɪ/. The means, standard deviations and mean percentages for the identification of this opposition appear in Table 4.

Table 4. The identification of the allophones of the opposition /ɪ/ - /e/.

| Vowel tested | Times tested | Mean | Stdev | % | t-value | significance |
|---|---|---|---|---|---|---|
| /ɪ/ | 4 | 8.3 | 9.29 | 33.0 | 3.561 | *** |
| /e/ | 4 | 17.0 | 8.04 | 68.0 | | |

The tense member of the opposition is in general better identified (17.0) than the lax one (8.3), and the difference is statistically very significant. Thus the contrastive expectation is confirmed. It is, however, questionable if the linguistic explanations *per se* are responsible for the result. An indication of this is the high standard deviations (9.29 for /ɪ/

[1] Finnish vowels may be phonemically short or long. According to Lehtonen (1969: 363), they can be described as "inherent qualities of the phoneme segments, as a suprasegmental phoneme of length or as a sequence of two segmental phonemes". Karlsson (1969: 354) and Wiik (1965: 12), for example, prefer the third interpretation.

and 8.04 for /e/), which imply that the identification was not consistent. Various pragmalinguistic reasons have distorted the picture. They have directed the identification process in conjunction with the linguistic factors and the result is higher scores for /e/ than for /ɪ/. Moreover, the discrimination percentages vary to a great deal, from 52 % to 88 %, the mean being 64.5 %. The result is partly explainable by the "inherent" difficulty of this opposition and partly by pragmatic factors such as the length of sentences and the familiarity of the structures tested.

*Opposition* /ɔ/ - /ɔ:/. - The opposition /ɔ/ - /ɔ:/ can be expected to cause difficulties of perception in the same way as the tense - lax oppositions dealt with above. Wiik's study (1965: 59) shows that the phonetic distribution area of the English /ɔ/ corresponds to that of the Finnish /o/, ie. positive transfer between the languages is possible. The allophones of English /ɔ/ lie between the phonetic distributional areas of Finnish /a/ and /o/. Finnish speakers may use the duration cue to perceive the distinction between the members of this opposition (see Lehtonen, Sajavaara and May 1977: 100). The means, standard deviations and mean percentages of the correct indentification for both opposition members are given in Table 5.

Table 5. The identification of the allophones of the opposition /ɔ/ - /ɔ:/.

| Vowel tested | Times tested | Mean | Stdev | % | t-value | Significance |
|---|---|---|---|---|---|---|
| /ɔ/ | 3 | 8.5 | 9.192 | 34.0 | 1.224 | none |
| /ɔ:/ | 3 | 11.7 | 9.392 | 46.8 | | |

The mean of the /ɔ:/ member is slightly higher than that of the /ɔ/ but no statistical significance between the means is found. The identification is not consistent, which is seen in the high standard deviations (9.192 and 9.392). The deviation for /ɔ/ is even greater than the mean itself. It is probable that the various factors (linguistic and especially pragmatic) have conflicted with each other, so that in one pair they have greatly favoured the identification of /ɔ/ and in another that of /ɔ:/. This has had a neutralizing effect on the identification of the opposition members as a whole. The mean discrimination percentage for this pair is 63.5 %, the range being from 84 % to 48 %. The highest percetage is at least partly due to the sentence final position of the opposition in

question and the lowest one to the falling intonation pattern.

*Opposition* /ʌ/ - /a/. - The English opposition /ʌ/ - /a/ is a potential source of difficulty for Finnish learners of English. According to Wiik (1965: 59) both the allophones of /ʌ/ and those of /a/ are within the phonemic area of Finnish single and double /a/. It is, however, probable that Finns can use the durational cue in their identification process. Serious problems may arise when the durational cue is neutralized (Lehtonen, Sajavaara and May 1977: 115). For example, Wiik's (1965: 80) study shows that Finnish speakers can hear no qualitative difference between the allophones of English /ʌ/ - /a/. According to Lehtonen, Sajavaara and May (1977: 113), the English /ʌ/ and the Finnish single /a/ are both acoustically and physiologically relatively similar to each other. Therefore it is difficult to form any hypothesis which would favour either the identification of /ʌ/ or that of /a/. The results of this opposition are shown in Table 6. The allophones of /ʌ/ have been somewhat better identified (mean 9.8) than those of /a/ (mean 6.8). The difference is not statistically significant. The high standard deviations (9.569) and 10.178) imply the inconsistency of the identification, ie. sometimes /ʌ/ and sometimes /a/ has been problematic. The same conflict of cues found in the oppositions dealt with above has also been present in the case of /ʌ/ - /a/ and resulted in a neutralizing effect. It was not possible to set up a contrastive hypothesis favouring either /ʌ/ or /a/. From this point of view the result is quite as expected. The discrimination percentages range from 88 % to 52 %, the mean being 64 %. The highest percentage is to some extent attributable to the prominent durational cue. The lower percentages seem to have something to do with the weak stress on the words containing the structures tested.

Table 6. The identification of the allophones of the opposition /ʌ/ - /a/.

| Vowel tested | Times tested | Mean | Stdev | % | T-value | Significance |
|---|---|---|---|---|---|---|
| /ʌ/ | 4 | 9.8 | 9.569 | 39 | 1.074 | none |
| /a/ | 4 | 6.8 | 10.178 | 27 | | |

*Opposition* /ɔ/ - /ʌ/. - The opposition /ɔ/ - /ʌ/ differs from the other vowel oppositions in that both members belong to the lax category. Because there is no tense - lax distinction in Finnish and many problems

arise from this phenomenon for Finnish learners of English, it is to be supposed that Finns would also have difficulties in distinguishing between the allophones of the two lax phonemes /ɔ/ and /ʌ/. For example, according to Lehtonen, Sajavaara and May (1977: 114), Finns have difficulties in perceiving the difference between the words *lock* and *luck*. It is, however, impossible to say which member of this opposition will cause more serious problems. The means, standard deviations and mean percentages for /ɔ/ and /ʌ/ are shown in Table 7.

Table 7. The identification of the allophones of the opposition /ɔ/ - /ʌ/.

| Vowel tested | Times tested | Mean | Stdev | % | t-value | significance |
|---|---|---|---|---|---|---|
| /ɔ/ | 3 | 8.7 | 4.503 | 34.7 | 3.287 | ** |
| /ʌ/ | 3 | 16.3 | 10.693 | 65.3 | | |

The mean of /ʌ/ (16.3) is higher than that of /ɔ/ (8.7) and the difference between the means is statistically significant. The identification of /ɔ/ is more consistent (standard deviation 4.509) than that of /ʌ/ (10.693). In general, the discrimination percentages are quite low (with one exception), which indicates that is may be difficult for Finns to hear the difference between /ɔ/ and /ʌ/. Since the linguistic cues are difficult to detect, the identification has taken place on grounds other than purely linguistic. Two of the opposition items were discriminated by 40 % of the informants and one of them by 96 %, the mean being 58.6 %. The low percentages are related to the lack of sentence stress on the words containing the structures tested, whereas the stress on the key words was especially prominent in the case of the 96 % discrimination.

*The discrimination and identification of the vowel oppositions: general notes.* - The discrimination and identification of the vowel oppositions is illustrated by Figure 3. The figure shows that neither the identification nor the discrimination percentages are very high (76 % or less). In general the oppositions have been better discriminated than identified. The low identification percentages are partly due to the fact that not all the testees were able to perceive the minimal distinctions in all positions. In the identification test they were not able to base their identification on the linguistic, ie. phonetic, cues maintaining the distinction in question. Therefore the identification was based on some other factors such as the meaning of the test sentences.

According to this study, the most difficult vowel opposition seems to be /ʌ/ - /a/ and the easiest /i:/ - /ɪ/, which is contrary to contrastively based expectations. However, the variation within each opposition is great; the same is true of the variation between the scores of the two perception tests (the discrimination percentages range from 96 % to 40 % and the identification percentages from 0 % to 92 %). If the number of the items tested in each case were increased, it might be possible that the discrimination and identification of all the vowel oppositions would become more and more uniform in such a way that their means would approach each other. The discrimination and identification of vowel oppositions is not necessarily based on the features detectable in the sound waves of speech simply because such cues are not prominent enough in all positions. The phonetic cues are not the only factors that direct the identification (and perhaps the discrimination) process. We cannot say that any particular vowel opposition would be difficult for Finnish learners without some reference to the position it occupies in the utterance.

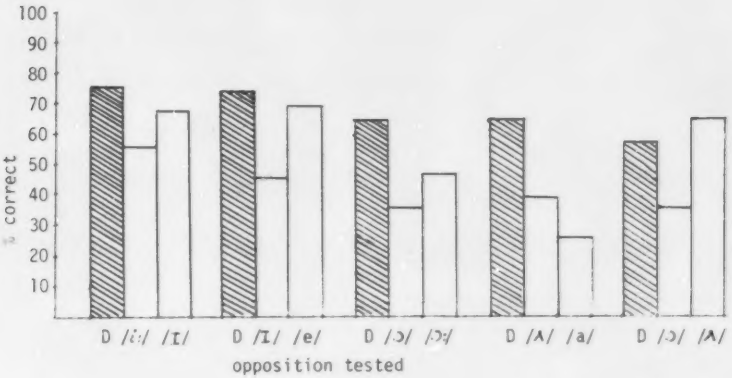



Figure 1. The discrimination and identification of the vowel oppositions; the mean percentages of correct identification and discrimination (y-axis) for the members of every vowel opposition (x-axis). Each opposition is presented by means of three columns; the one with oblique lines (= D) stands for the mean discrimination percentage and the blank ones give the identification percentages for both opposition members.

*Consonant oppositions. - Plosive oppositions.* - Phonologically the members of the English plosive oppositions (/p/ - /b/, /t/ - /d/ and /k/ - /g/) differ in regard to one phonological feature called fortis - lenis or voiced - voiceless[1]. According to markedness theory, the lenis member has something that the fortis member lacks; the fortis member can be specified by the absence, and the lenis member by the presence, of the feature. Theoretically, it might be supposed that the lenis member is more complex and more difficult than its fortis counterpart. However, the phonological features as such do not necessarily say much about the phonetic manifestation of the fortis - lenis distinction.

The oppositions of English plosives are difficult for Finnish learners of English, because Finnish has only one series of plosive consonants /p t k/. The phonemic status of /d/ has been disputed. Theoretically we can find minimal pairs where it is phonologically distinctive, eg. *maton* ('of a carpet') and *madon* ('of a worm'). However, in many Finnish dialects the opposition /t/ - /d/ is nonexistent or /d/ is represented by a flap and not a plosive (for example, in the Ostrobothnian dialect spoken by the subjects of this study /d/ is often replaced by /r/). According to Karlsson (1971: 32) it is a result of morphological alterations in the surface structure. In physiological terms, the difference between Finnish /t/ and /d/ is primarily in the place of articulation (Lehtonen, Sajavaara and May 1977: 131; Sovijärvi 1973: 47; Wiik 1965: 84). Thus Finnish lacks fortis - lenis oppositions.

Phonetically the English plosive oppositions are characterized by many cues, whose importance varies according to context. According to Suomi (1976: 2), most of these cues also occur in Finnish but they are not distinctive. Their function is mainly syntagmatic. Suomi (1976: 19) and Hänninen (1977: 15) found that Finns tend to pronounce English initial /p t k/ with some voice whereas in English no voice is present in this position (see eg. Gimson 1966: 153). Therefore Finns have to learn to reorganize the cues in order to discriminate and identify fortis - lenis oppositions. Finnish plosive consonants are somewhere between the corresponding English fortis and lenis plosives (Lehtonen, Sajavaara and May 1977: 128). In Wiik's (1965: 21) terminology the difference between

[1] In this study the terms fortis and lenis are used in connection with phonological distinctions and the pair voiceless - voiced refers to the phonetic manifestation, ie. vocal fold vibration.

Finnish and English plosives is relational because the sounds that are phonologically distinctive in the TL are in free variation in the NL. Thus it is difficult to predict - in contrast to many vowel oppositions - which member of a particular opposition is more difficult. In each case, various cues may signal the same member of an opposition. Therefore we must attempt to find certain phonetic manifestations that in some position may help in, or interfere with, the process of identification and discrimination. Because no instrumental sound wave analysis of the productions of the stops in this study has been made, the proposed cues cannot be of very precise nature.

*Opposition* /p/ - /b/. - The means, standard deviations and mean percentages of the correct identification of the allophones of the opposition /p/ - /b/ are presented in Table 8. The results show that the mean of /b/ (13.7) is somewhat higher than that of /p/ (11.0). The difference between the means is not, however, statistically significant, and the members of this opposition are nearly equally well identified. The results support the postulation by Suomi (1976: 74-75) that both members are difficult for Finnish learners. Finnish /p/ is usually unaspirated (see eg. Lehtonen 1970: 51), and it can be partially voiced, which is reflected in the way Finnisn informants produced English voiceless stops in Suomi's (1976: 19) and Hänninen's (1977: 15) study, whereas, English /p/ is aspirated and voiceless in the initial stressed position (Gimson 1966: 159). English /b/ is partially (or fully) voiced in that position (Gimson 1966: 160). Therefore the cues of Finnish /p/ do not match with those of English /p/ and /b/. An example of this is seen in Moisio and Valento's (1976: 33) study, where English initial /p/ was sometimes transcribed as Finnish <p> and sometimes as <b>.

The low discrimination and identification percentages imply the difficulty of this opposition for Finns. In interpreting the results the pragmatic factors must, however, be taken into account. For example, the high identification percentage of /b/ in the pair *pike - bike* is clearly attributable to strong pragmatic cues, which is reflected in the high standard deviation of /b/ in Table 8. The other pairs show that /p/ would be easier than /b/ to identify in the initial position. The results are, however, a sum of the linguistic and pragmatic factors and they may vary from context to context. Idiolectal variation is also possible. An indication of this may the fact that the highest discrimination percentage (56 %) was obtained in a sentence pair where no sentence stress occurred

on the words containing the structures tested, whereas in stressed position the discrimination percentages were 44 %.

Table 8. The identification of the allophones of the opposition /p/ - /b/.

| Consonant tested | Times tested | Mean | Stdev | % | T-value | Significance |
|---|---|---|---|---|---|---|
| /p/ | 3 | 11.0 | 7.937 | 40.0 | 1.124 | none |
| /b/ | 3 | 13.7 | 9.018 | 54.8 | | |

*Opposition /t/ - /d/.* - The results for the opposition /t/ - /d/ are given in Table 9. No statistical difference between the means of /t/ (14.3) and /d/ (13.5) exists, which means that both members are equally well identified. The situation is more or less the same as that of /p/ and /b/. The cues of both /t/ and /d/ are unfamiliar to Finnish informants, especially if they occur in weakly stressed word-final positions and are one reason for assuming that pragmatic cues very strongly affect the perceptual process. On the whole, the results support the hypothesis that both /t/ and /d/ are difficult for Finnish learners. This reasoning is supported by the discrimination test results; the solving percentages range from 52 % to 84 %, the mean being 67 %. The high percentages are without exception characterized by strong stresses on the key words, whereas the low percentages are characterized by the lack of sentence stress on the sounds tested and word-final positions (ie. *ride - write, spend - spent*).

Table 9. The identification of the allophones of the opposition /t/ -/d/.

| Consonant tested | Times tested | Mean | Stdev | % | T-value | Significance |
|---|---|---|---|---|---|---|
| /t/ | 4 | 14.3 | 5.909 | 57 | 0.411 | none |
| /d/ | 4 | 13.5 | 6.952 | 54 | | |

*Opposition /k/ - /g/.* - The results for /k/ and /g/ are shown in Table 10. The means of /k/ and /g/ (13.8 and 15.3) do not differ in a statistically significant way. Therefore the situation is the same as for the other plosive oppositions. Both members are equally difficult.

The discrimination scores are highly deviant; the solving percentages range from 44 % to 88 % (mean 72 %). The highest score seems to be attributable to a strong stress on the key words and to a rising intonation on the words, which affects the length of the preceding vowels (ie. the word-final fortis - lenis distinction becomes more prominent). The lowest percentage 44 % is found in stressed word-initial positions. Therefore its difficulty is probably explained by the idiolectally "unclear" nature of the sample in question.

Table 10. The identification of the allophones of the opposition /k/ - /g/.

| Consonant tested | Times tested | Mean | Stdev | % | T-value | Significance |
|---|---|---|---|---|---|---|
| /k/ | 4 | 13.8 | 6.652 | 55 | 0.869 | none |
| /g/ | 4 | 15.3 | 5.500 | 61 | | |

The fortis series /ptk/ is distinguished in final position from the lenis series /bdg/ either by reduction of the length of the sounds preceding /ptk/ or the presence of some voice in /bdg/ or possibly by the combination of the two (Gimson 1966: 156). Because the functioning of the final consonants as cues *per se* is subject to idiomatic variations especially in regard to the extent of release (Gimson 1966: 156), the main cue seems to be the length of the preceding sound. The importance of the length of the preceding vowel is amply documented (see eg. Denes 1955: 763; Peterson and Lehiste 1960: 700-701; Wiik 1965: 116-117; Wang 1967: 343; Mazzarella 1971: 20). Finnish informants cannot, however, use this cue though they have learnt to utilize the duration of sounds in their own language. According to Suomi (1976: 9), the reduction of the preceding vowel is more drastic in English than in Finnish. It is probable that the Finnish informants expected the voiced - voiceless cue, which is often mentioned in textbooks as the only cue for the fortis - lenis distinction.

*Affricate oppositions.* - On the abstract level of phonology the members of the English affricate opposition /tʃ/ - /dʒ/ differ from each other in terms of one phonological feature, fortis - lenis, like the plosives above. In Trubetzkoy's (1958: 75) terms we are concerned with a privative opposition. This kind of description does not, however, say very much about the actual perceptual cues of this opposition.

According to Lehtonen, Sajavaara and May (1977: 139), the difficulties encountered by Finns in learning the English affricates are similar to those of the plosives: both members are difficult. From the point of view of a Finnish learner, the situation derives from a physical difference between the TL and the NL (Wiik 1965: 17) because no affricates occur in Finnish. The most important phonetic cues given by Gimson (1966: 173) are "the transition between the preceding vowel and the stop" together with "the explosive onset of friction". According to Strevens (1960: 41), there is "a brief intervening [s] or [z] -like friction before [ʃ] and [ʒ] elements". In other words, the cues are based on various kinds of noise bursts and frictions. This situation serves as a potential source of difficulty because "a Finn may have a tendency to underdiscriminate the various kinds of noise bursts which appear after the release of the initial alveolar plosive in English" (Lehtonen, Sajavaara and May 1977: 139).

*Opposition* /tʃ/ - /dʒ/. - The means, standard deviations and mean percentages for the identification of /tʃ/ and /dʒ/ are presented in Table 11. The mean of the lenis member /dʒ/ is clearly higher than that of the fortis member /tʃ/ (20.7 and 5.3, resp.). The difference between the means is statistically very significant. Thus the contrastive expectation is not supported. This does not, however, mean that in a purely linguistic sense the lenis member would be as difficult as the statistics show. In all the three tests the lenis member was favoured by strong pragmatic cues whereas the fortis member did not have this kind of advantage. The discrimination percentages were quite low, 56 % (except in *chin/gin*, 88 %). This may be connected with the "inherent" difficulty for Finnish speakers of perceiving the distinction between /tʃ/ and /dʒ/. For example, Moisio and Valento (1976: 74-75) found this opposition to be one of the most difficult among the English consonant oppositions for Finnish learners to identify (the identification test, however, differed from the one used in this study). In two cases the discrimination test percentage was 56 % and in one case 88 % (mean 66.7 %). This speaks in favour of the "inherent" difficulty of this opposition. The high percentage is explained by the "clear" idiolect of the sample in question.

Table 11. The identification of the allophones of the opposition /tʃ/ - /dʒ/.

| Consonant tested | Times tested | Mean | Stdev | % | T-value | Significance |
|---|---|---|---|---|---|---|
| /tʃ/ | 3 | 5.3 | 2.082 | 21.3 | 23.572 | * * * |
| /dʒ/ | 3 | 20.7 | 2.517 | 82.7 | | |

*Other consonant oppositions.* - *Opposition /tr/ - /dr/.* -The potential difficulties of /tr/ - /dr/ are in the fortis - lenis character of this opposition (ie. the distinction between /d/ and /t/ and in the release of the initial stop). In addition, the linking of /t/ and /d/ with /r/ may cause perceptual problems due to the different shades of friction. The problems are similar to those of /tʃ/ - /dʒ/.

Far-reaching conclusions about the difficulty of the /tr/ - /dr/ opposition are not possible. It seems that this opposition is problematic for Finns. The discrimination percentages are low (16 % and 48 %) and the identification is mainly based on pragmatic cues. An interesting detail is also the Finnish learners' problems in perceiving the difference between /tʃ/ and /tr/. On the whole the results support Moisio and Valenio's (1976: 74-75) findings about the difficulty of the /tr/ - /dr/ opposition, although the lowest discrimination percentage (16 %) seems to be partly caused by the "mashing" effect of linking.

*Opposition /s/ - /θ/.* - The opposition /s/ - /θ/ is different from the oppositions dealt with above in that the distinction between its members is not that of fortis - lenis. Instead, the minimal difference is maintained by the place of articulation, /s/ being alveolar and /θ/ dental (see Lehtonen, Sajavaara and May 1977: 143-144). Both members belong to the fortis series. A comparison of the Finnish and English fricatives shows that in English five places of articulation (labiodental, dental, alveolar, palato-alveolar and glottal) are distinguished whereas the number of the places distinctive in Finnish is only two[1] (dental and glottal). Therefore speakers of English must make subtler distinctions between various kind of frictional noises than speakers of Finnish. Lehtonen, Sajavaara and May (1977: 145) point out that "a Finn has to learn to hear the difference in quality between the 'sharp s' and the 'hushing s' as well as between the tense (voiceless) and lax (voiced) fricative". According to Gimson (1966: 180), one of the cues for fricatives is the extent and position of the noise component. The continuous noise ranges from about 3600 to 8000 cps for /s/ and from about 1400 to 8000 cps for /θ/ (see also Strevens 1960: 41; Hughes and Halle 1956: 306-307). The intensity of /s/ is also greater than that of /θ/ (Gimson 1966: 180). Perhaps the most important cue is, however, in the nature of the adjacent

[1] The position of /f/ is marginal in the Finnish phonological system because it occurs only in some loan words, often pronounced as /v/.

vocalic glide (Gimson 1966: 180). As a whole both /s/ and /θ/ are liable to cause discrimination and identification problems. The opposition /s/ - /θ/ seems to be difficult both to identify (mean 65 %) and to discriminate (mean 66 %). However, most of the problems are caused by the pragmatic cues, perhaps because linguistic cues are - for one reason or another - very weak.

*Opposition* /ʂ/ - /tʃ/. - The distinction between the palato-alveolar /ʃ/ and /tʃ/ is that /ʃ/ is a fricative and /tʃ/ an affricate. The status and cues of the affricates were discussed above. According to Gimson (1966: 180), the acoustic cues of /ʃ/ are the extent and position of the noise component, a continuous noise in the spectrum ranging from about 2000 to 7000 cps. Similarly to /s/, /ʃ/ has a relatively high intensity. Finnish has no corresponding sound, except in certain loan words, but even there its realization is not usually [ʃ] but rather [s], for example in the word *Šakki* ('chess'). The area of the variation of the Finnish /s/ is quite extensive. This is implied by Mazzarella (1971: 21) when he states that "Finnish speakers pronouncing English make the hiss of English /s/ too sharp so that an Englishman may hear it as /ʃ/". The difference between Finnish and English is, in Wiik's (1965: 17) terms, physical both in /tʃ/ and in /ʃ/. The fact that in Swedish the sounds [ʃ] and [tʃ] may be in free variation may be confusing because the informants have studied Swedish for three years. In brief, both /tʃ/ and /ʃ/ are liable to cause identification and discrimination problems. In Moisio and Valento's (1976: 74-75) study, this pair was found to be fairly easy. It may be easy if certain conditions prevail but difficult under different conditions, for example when connected with some other sounds or when some pragmatic cues are present. A reflection of this is given by the fact that the discrimination scores ranged from 92 % to 40 % and the identification ones from 92 % to 40 %.

*Opposition* /tʃ/ - /dz/. - The members of the opposition /tʃ/ - /dz/ differ from each other in that /tʃ/ is a voiceless affricate and /dz/ a voiced consonant cluster. The phonemic status and the identification cues of /tʃ/ were discussed above. The distribution of /dz/ is mainly limited to the word-final position (Gimson 1966: 171). This is one reason for the cluster interpretation of /dz/. Since the documentation of the acoustic cues of /dz/ is scanty, both /d/ and /z/ will be dealt with separately. For the cues of /t/, see above. /z/ can be defined as a voiced alveolar fricative. The continuous noise in its spectrum ranges from 3600 to 8000

cps (Gimson 1966: 180), ie. the noise has a relatively high frequency. The duration of /z/ is long and its intensity low. Thus the difference between /tʃ/ and /dz/ may be both in voice and in friction. However, the most important cue in the word-final position is the length of the preceding segments, while a reduction takes place in front of the fortis member of the opposition. The single /tʃ/ - /dz/ opposition included in this study was discriminated by only 36 % of the informants probably because none of the informants were able to use the length cue mentioned above. The identification took place mainly by means of pragmatic cues as the quite high percentages, 64 % and 80 %, show.

*Consonant oppositions: general notes.* - Figure 2 illustrates the identification and discrimination of the consonant oppositions included in this study.

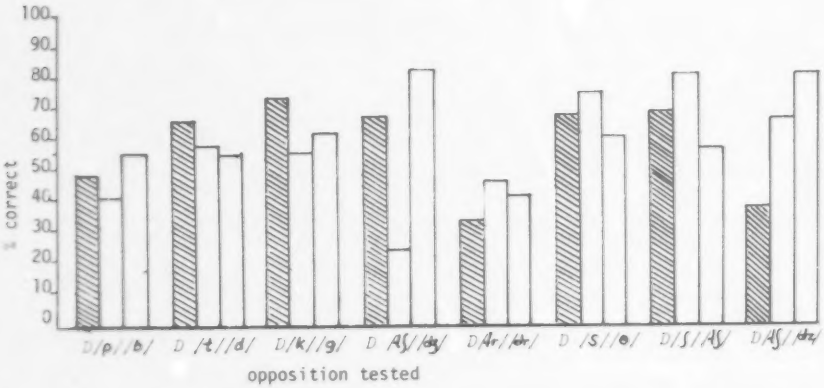



Figure 2. The discrimination and identification of the consonant oppositions; the mean percentages of correct identification and discrimination (y-axis) for the members of each opposition (x-axis). Each opposition is presented as a group of three columns; the one with oblique lines stands for the mean discrimination percentage and the blank ones give the mean identification percentages for both opposition members.

The mean percentages of both discrimination and identification in each opposition correspond to each other quite well. The oppositions that contain only one or two items tested show greater internal variation. Therefore it seems that when the number of items is increased, the solution (mean) percentages become more uniform, ie. the effect of various fluctuations is neutralized. In some pairs both members are difficult for

Finnish learners, which tends to make solution percentages more uniform.

The most difficult opposition included in this study was /tr/ - /dr/, which supports the idea of its being a special case of the /t/ - /d/ opposition. A striking phenomenon was the low identification percentage of /tj/, which can largely be explained by pragmatic criteria. The same trend is also seen in /tʃ/ - /dz/, where the discrimination percentage is very low and the identification took place by means of other than linguistic cues.

In general it is difficult to say which oppositions cause the greatest difficulties for Finnish learners because the context (both linguistic and pragmatic) greatly affects the degree of difficulty in each case. For example, the falling of the sentence stress may complicate or facilitate the processes of discrimination and/or identification. The English consonants are not easy or difficult in themselves: difficulty or ease is a function of the specific conditions in which the consonants occur.

*Juncture oppositions. - Junctures in Finnish and in English.* - The review of the concept of juncture revealed that the existence of various boundaries may be determined by grammatical criteria. For the comparison of Finnish and English junctures the function of the linguistic unit called word becomes essential. According to Karlsson (1977: 59), the word carries more information in synthetic languages (like in Finnish) than in analytic languages (like in English). Accordingly, the word in Finnish is a more important unit both semantically, grammatically and perceptually than the word in English. This is reflected, for example, in the difficulty of defining the concept word in English. The importance of the word means that there is a greater need in Finnish for word-internal cohesion and also a greater need for boundary markers in Finnish than there is in English (for more details, see Karlsson 1977: 59-63).

Certain phonotactic rules signal word boundaries in both languages. In Finnish, no consonant clusters are permitted in the initial position of a word (except in loan words). The clusters /sr/ and /lr/ do not occur in word-medial positions whereas /ps/ and /pl/ are found in these positions only (Wiik 1973: 47). Simple velars and labials are not permitted in word-final positions (Karlsson 1977: 65). Consonant clusters are negative boundary markers indicating that the word continues (see Trubetzkoy 1958: 277).

In Finnish, vowel harmony requires that the front vowels /y, ö, ä/[1] cannot coexist in the same word with the back vowels /u, o, a/ (see eg. Wiik 1973: 47; Trubetzkoy 1958: 284-285; Lehtonen, Sajavaara and May 1977: 152). For example, the string of sounds /yöjuoksu/ is perceived as two words. Because the suffixial vowels of a Finnish word are determined by the vowels of the root, vowel harmony also contributes to word-internal cohesion (Karlsson 1977: 65). In addition, the morphophonemic alternations create redundancy because, for example, the alternations in the suffixes can be predicted by the alternations of the root. The redundancy on its part facilitates decoding (see Karlsson 1977: 68).

No phenomenon equivalent to Finnish vowel harmony exists in English, and certain other phonotactic rules signal word boundaries. /ŋ/ does not occur in word-initial positions and therefore no boundary is possible before /ŋ/. /r, j, w/ can occur in clusters as non-initial elements. In word-final positions only /l/ may occur before non-syllabic /m, n/ (for these and other examples, see eg. Gimson 1966: 239-256).

The phonotactic rules set up the possibilities of the occurrence of word boundaries, but, in the actual manifestation of the word level junctures, various phonetic cues are present. In Finnish words, the primary stress is on the first syllable and it acts as a positive boundary marker indicating where the word begins (Trubetzkoy 1958: 277). In English, the main stress of a word is not necessarily on the first syllable (Gimson 1966: 222). Therefore the English word stress is not such a uniform boundary signal as the Finnish one.

According to Lehiste[2] (1964: 174), in a Finnish vowel + vowel sequence the occurrence or non-occurrence of a word boundary between the two vowels is signalled by the quality of the second vowel; a reduced vowel signals the absence of a juncture and a non-reduced the presence of one. In English, the quality of vowels may also serve as boundary signals in some cases, for example the pair *I scream - ice-cream* is differentiated, among other things, by the long and reduced /aɪ/ element (Gimson 1966: 375).

[1] In the phonetic transcription Finnish letters have been used since they refer to the corresponding phonemes in one-to-one relationship.

[2] Lehiste compared some Finnish compounds whose first part ends in a vowel and whose second part begins with a vowel with similar non-compound words, eg. /lintuansa/ (object form of 'his bird') - /lintu-ansa/ ('bird trap'). The differences between the manifestations of the V + V sequence were interpreted as signals of the presence or absence of a word boundary.

The duration of the second component in a Finnish V+V sequence is longer if the word boundary falls between the vowels than if there is no boundary (Lehiste 1964: 175). A similar tendency is seen in English, where Lehiste (1960: 42) found initial allophones to be considerably longer than the medial or post-junctural ones. For example, the initial plosive /t/ was about five times as long as the medial /t/. Moreover, nazalisation can be a juncture cue in Finnish (Lehiste 1964: 77).

Su, Daniloff and Hammarberg (1975: 254) tried to find out whether nasal coarticulation can mark the presence of a juncture in English. However, low level junctures were marked with little pause (= lack of coarticulation) and only clause boundaries showed consistent pauses.

The use of glottalization or a glottal stop as a juncture cue has been reported in both Finnish (eg. Lehiste 1964: 175) and in English (eg. Lehiste 1960: 45). According to Lehtonen and Koponen (1977: 76-79), the distribution and function of the glottal stop is, however, different in these languages. In English, glottalization may occur in word-initial and word-medial positions in front of a syllable beginning with a vowel. In Finnish, it is possible only at a word boundary. Lehtonen and Koponen (1977: 79) say that "the essential difference in the occurrence of glottalization in English and in Finnish is, thus, the fact that English glottalization is a phonetic means connected with syllable boundaries and emphasis, and not an unambiguous marker at word boundaries. In Finnish, glottalization can never be used word-medially to mark a syllable boundary beginning with a vowel."

Because glottalization can occur only between words in Finnish, Finnish speakers may also regard it as a word boundary cue in English. This is supported by the study by Lehtonen and Koponen (1977: 75, 84). In front of words beginning with a vowel[1], Finns used glottalization more frequently than it was used in standard English pronunciation. Glottalization was also often used instead of linking (Lehtonen and Koponen 1977: 76).

The aspiration of the English fortis plosives in the initial position and the lack of aspiration in other positions may serve as a strong cue for English speakers (Christie 1974: 819; Lehiste 1960: 42-43). For example, in the pair *keep sticking - keeps ticking* the /t/ of the first

[1] In Finnish, glottalization is used above all as a boundary signal in connection with words beginning with a vowel.

member is unaspirated and that of the second member is aspirated. No corresponding phenomenon can be found consistently in Finnish.

The comparison of juncture cues in English and Finnish shows that their correspondence is not very great. It seems that Finnish speakers use English cues only accidentally, for example, when a glottal stop happens to occur at a word boundary or when the primary stress happens to fall on the first syllable of a word. The problem is also complicated by the fact that the realization of phonetic cues is often speaker-dependent (see, eg., Kent *et al* 1974: 470; Moll and Daniloff 1968: 680) to such an extent that they may become neutralized in connected speech (Gimson 1966: 301). This gives reason to suppose that pragmatic cues can be quite strong in the perception of juncture oppositions.

*Identification of juncture oppositions.* - The identification and discrimination percentages (y-axis) of the juncture oppositions (x-axis) are presented in Figure 5 below in the form of a diagram. The figure shows that the identification of the juncture oppositions is inconsistent both between and within the oppositions (solving percentages range from 4 % to 100 %). The same applies to the discrimination percentages (from 20 % to 96 %). In general, the linguistic cues that Finnish informants use in perceiving juncture oppositions are the occurrence of the word stress on the first syllable of an English word or a period of glottalization preceding a word beginning with a vowel. The highest percentage is elicited by a glottal stop in front of a vowel in the initial position of a word, ie. in the case of the pair *That prince S/princess is our friend.* Some other similar pairs (*the meat - them eat; grey tie - great eye; a tower house - at our house; a name - an aim; free Danny - freed Annie*) which did not have any glottal stop or had a very weak glottalization in this position were clearly more poorly discriminated than *prince S - princess.* So it seems that the glottal stop for Finns must be "clearly" perceptible.

Many other cues found to be responsible for the phonetic manifestation of junctures in some previous studies (eg. Lehiste 1960: 19, 30, 35; Hoard 1966: 98-103; Gimson 1966: 300), such as the quality and length of segmental sounds, provided they have been present in the samples of this study, have not been prominent enough for Finnish informants to use. This becomes understandable if we know that many of the durational and quality cues were found to be inconsistent and even native speakers found it difficult to perceive distinctions like these (see eg. Hoard 1966: 101). According to Gimson (1966: 300), "the function of these cues depends on

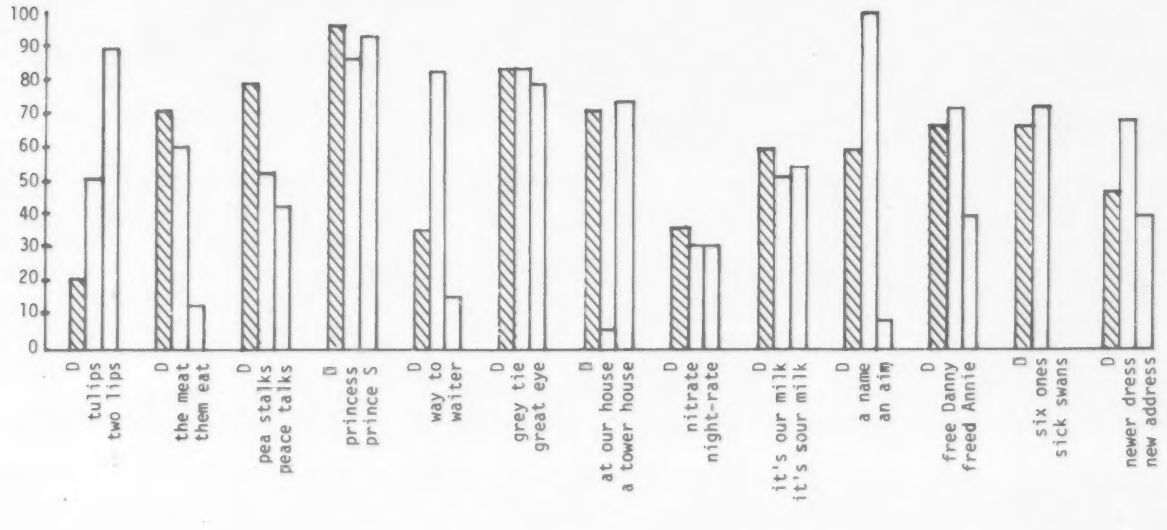



Figure 5. The discrimination and identification of the juncture oppositions; the percentages of correct identification and discrimination (y-axis) for the members of each juncture opposition (x-axis). Each opposition is presented as a group of three columns; the one with oblique lines stands for the discrimination percentage and the blank ones give the identification percentages for both opposition members separately in case of each opposition.

the speaker's consciousness of the word as an independent entity." In other words, various linguistic cues are products of the particular idiolect in question. The realization of the "theoretical" cues obviously differs both interpersonally and within every speaker's pronunciation. Some good examples of the pairs containing weak cues in this study are *tulips - two lips, way to - waiter* and *nitrate - night-rate*. In these cases the linguistic cues have been small and difficult to detect and the identification has been based on pragmatic cues such as sentence meaning. In fact, the number of pragmatic cues is quite great for many pairs. This might mean that the abstracting of word boundaries is really a great problem for Finns learning English.

*Sentence stress oppositions.* - Sentence stress has two functions in English (see eg. Lehtonen, Sajavaara and May 1977: 67-69; Lehiste 1969: 150-151; Bolinger 1961: 83; Malmberg 1968: 111). Firstly, every sentence has a normal non-emphatic and unmarked sentence stress, which is predictable by means of the syntactic structure of the sentence. Secondly, if the purpose is to give more emphasis to a word or a morpheme, contrastive of emphatic stress is applied. For instance, in the example given by Lehtonen, Sajavaara and May (1977: 68) *Yesterday I bought a women's bicycle*, the semantically and logically most important words are stressed, ie. the words *yesterday* and *bicycle*. But if this unmarked stress pattern is changed, for example, by giving the word *bought* a special emphasis, the underlying structure and thus the meaning of the sentence changes (about the surface and deep structure interpretation of contrastive stress see eg. Bresnan 1971: 269 and 1972: 326-327; Chomsky and Halle 1968: 15; Berman and Szamosi 1972: 319).

In Finnish sentence stress can express roughly similar phenomena as in English. According to Wiik (1977: 45-46), it can signal the constituent structure of an utterance, the theme-rheme relationship or contrast (see also Nurmela 1934: 180; Lentonen, Sajavaara and May 1977: 68).

The phonetic cues responsible in English for the realization of stress are quite unanimously and amply documented; the pitch of the voice, the quality of vowels, the duration of segments and the intensity of voice (see eg. Lehtonen, Sajavaara and May 1977: 69; Lehiste 1969: 131; Morton and Jassem 1965: 178; Fry 1965: 151; Lieberman 1960: 451; Brown and McGlone 1974: 971; Adams and Munro 1978: 153). According to Lehtonen, Sajavaara and May (1977: 68), the most effective cue both in Finnish and English is the change in the pitch of voice, although the pitch variations

in Finnish are much smaller than in English. Thus, Finnish learners of English are not accustomed to such extensive pitch variations as exist in English. The placement of stress is, however, largely determined by the meaning to be conveyed (eg. Gimson 1966: 258) and, accordingly, by the context and situation where the particular sentence occurs. Therefore pragmatic cues may have a central role in the discrimination and identification of sentence stress oppositions.

*The discrimination and identification of sentence stress.* - The discrimination and identification percentages (y-axis) of each sentence stress opposition (x-axis) are presented in Figure 6. It shows that the problems related to sentence stress are of two sorts. Firstly, all the informants have not been able to perceive sentence stress distinctions. With two exceptions, the discrimination percentages fall between 64 % and 76 %. The fact that the solving percentages of the oppositions are quite evenly distributed makes the difficulty consistent. The two deviating discrimination percentages (ie. 28 % for *'White House/white 'house* and 96 % for *'visiting friends/visiting 'friends*) seem to be related to the idiolect of the test samples.

The second problem is related to the function of the sentence stress, ie. the learner must understand the underlying structure maintained by the sentence stress. One probable explanation for that is that the learners have not always known on which part of the utterance the sentence stress should fall to give a particular shade of meaning. Often this has to do with the understanding of grammatical structures. The situation is further complicated by a quantity of pragmatic cues directing the identification process.

The effect of all these factors is reflected in the high deviations among the identification scores (ranging from 8 % to 88 %). Two identification scores even exceed the corresponding discrimination result. The results show that Finnish comprehensive school pupils may have difficulties of the same degree with sentence stress as with segmental sounds or junctures even though in principle the functions and the phonetic cues of sentence stress both in Finnish and English are to a great extent similar.

*Difficulties related to the identification and discrimination of the oppositions.* - The difficulties related to the identification and discrimination of the oppositions tested are caused by a number of factors in each particular case. The factors are quite heterogeneous, because they vary greatly from context to context.

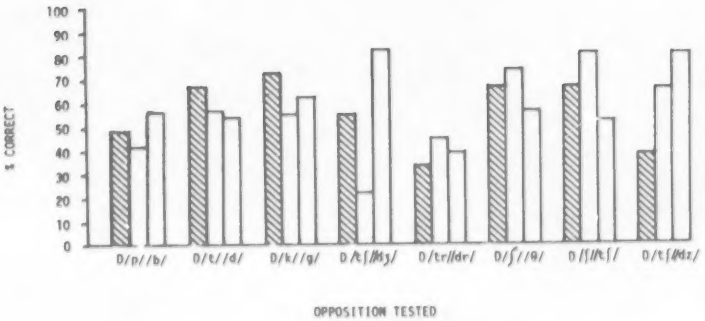



Figure 4. The discrimination and identification of the sentence stress oppositions; the percentages of correct identification and discrimination for the members of each sentence stress opposition. Every opposition is presented by means of three columns; the one with oblique lines (= D) stands for the discrimination percentage and the blank ones stand for the identification percentages.

The difficulty of the oppositions does not vary according to linguistic categories (ie. vowels, consonants, junctures and sentence stress). Table 12 below shows the mean scores, mean percentages and standard deviations for the discrimination and identification of the items belonging to these categories separately and for the identification and discrimination skills in general.

Table 12. The means, ($\bar{x}$), mean percentages ($\bar{x}$ %), and standard deviations (d) of the discrimination and identification of the vowels, consonants, junctures and sentence stress

| Structure tested | Number of times tested | Discrimination | | | Identification | | |
|---|---|---|---|---|---|---|---|
| | | $\bar{x}$ | $\bar{x}$ % | d | $\bar{x}$ | $\bar{x}$ % | d |
| Vowels | 18 | 17.0 | 68.0 | 4.49 | 11.9 | 47.8 | 8.03 |
| Consonants | 21 | 14.9 | 59.4 | 5.26 | 14.0 | 56.0 | 6.77 |
| Junctures | 13 | 15.4 | 61.5 | 5.37 | 13.5 | 54.2 | 7.43 |
| Sent. Stress | 8 | 17.1 | 68.5 | 4.76 | 11.9 | 47.8 | 6.61 |
| Total | 60 | 16.1 | 64.4 | 4.97 | 12.8 | 51.5 | 7.21 |

The figures indicate that both in the case of discrimination and of identification the differences in difficulty between the categories are very small indeed; in the discrimination the greatest variation, which is between the sentence stress (mean 68.5 %) and the consonants (mean 59.4 %), is only 9 %; in the identification the greatest variation, about 8 %, is found between the consonants (mean 56.0 %) and the vowels/sentence stress (mean for both 47.8 %). Accordingly, the division of the oppositions into suprasegmentals (= juncture + sentence stress) and segmentals (= vowels + consonants) does not imply any clear difference in difficulty. A lot of inconsistency is also found in the identification and discrimination of the various subclasses of the vowels and consonants (eg. /ʌ/ - /a/ and /p/ - /b/).

Because the difficulties are not distributed according to the linguistic categories mentioned above, it is to be concluded that the oppositions occurring in sentence pairs are not necessarily easy or difficult as such; instead, the difficulty is determined by the positions they occupy in an utterance or expression. Therefore the independence of the sentence pair oppositions is more limited than that of the word pair

oppositions, for example. This is reflected for instance in the fact that contrastive predictions fall short in many cases in predicting the perceptual problems of the sentence pairs; the power of contrastive predictions varies because they are supposed to forecast the possible difficulties between phonologically distinctive units in carefully controlled circumstances, ie. extracted from the context in which they are found in utterances.

The importance of an opposition can be evaluated only if we know all the linguistic and non-linguistic cues related to its perception. In each case a bundle of cues is responsible for a particular identification or discrimination result. The bundle of cues differs greatly from one situation to another. This is clearly seen when the discrimination and identification of the sentence pairs are compared. Though discrimination, in general, seems to be an easier process than identification (mean solving percentages 64.4 % and 51.1 %, respectively), the variation within identification and discrimination and also between them is great. One and the same opposition may obtain clearly different identification and discrimination percentages in various positions. The identification score may in some cases be even higher than the discrimination score (eg. *Ted - dead*). A common phenomenon is that one member of an opposition is so much better identified than the other that its percentage exceeds the discrimination score of the respective pair. This seems to be especially the case when the discrimination score, for one reason or another, has remained low. This means that when the informants cannot perceive the linguistic cues properly they rely on other cues. This may sometimes facilitate the identification of one member but at the same time make the identification of its opposite member difficult. This would mean that the role of the oppositions *per se* for the understanding of utterances would decrease and the importance of the other cues would increase. The fact that the informants regarded the identification test as easier than the discrimination test may indicate that the informants have often used sentence cues and disregarded those belonging to phonology because they might have been difficult to detect.

The reasons for the utterance dependence of the difficulties caused by the various oppositions are to be found in the redundancy present in speech. The native speaker needs to hear only a part of an utterance to understand the message. He can make predictions about the coming speech and fill in the possible gaps in the code (see eg. Tommola 1977: 25; Lehtonen, Sajavaara and May 1977: 18-19). The situation of the native

speaker is different from that of a foreign language learner, because the FL learner cannot always use redundancy to a similar extent. He must perceive a number of cues in order to understand the message; if he cannot hear as many cues as are necessary for understanding, he must fill in the gaps with some sort of meaningful cues. He may sometimes be able to hear the purely linguistic cues but sometimes he must rely on pragmatics. Therefore the fundamental difficulty in the perception of the phonological distinctions occurring in sentences is in the interpretation of all the cues that are available in the situation. It is impossible to predict exhaustively what cues will be present; sometimes they are linguistic, sometimes not, sometimes the linguistic cues are important, in other cases not, etc.

*An examination of the pragmatic cues.* - The important part that the pragmatic cues play as independent variables explaining the discrimination and identification test results makes it necessary to examine these cues in more detail. Pragmatics - though its definition may vary (see eg. Groenendijk and Stokhof 1978: 51) - regarded as a part of communicative competence, the other part of which is grammatical competence, ie. the interrelationship between form and meaning (see eg. Wales and Campbell 1977: 249; Hymes 1971: 282; Corder 1973: 92; Sajavaara 1977: 21; Sajavaara and Lehtonen 1977: 14; Kohonen and Saleva 1978: 13). According to Sajavaara (1977: 14), pragmatics is a set of rules for the mutual interaction of people in speech situations. Sajavaara (1977: 21-22) gives a list of the possible parametres which may play a role in a communicative act: "speaker, hearer, time and place, code (broken down to various components), channel, various prerequisites of the speaker-hearer (knowledge of the world, knowledge of the other parties of the speech event, social relationships and roles including various rules of politeness and hierarchies, norms, understanding of earlier messages, most of which is normally covered by the concept of presupposition), intentions of the speaker and hearer, affective states, non-verbal elements of the communicative act and problem solving capacity". The scope of the present study does not, however, include any interactional speech events and therefore the subjects act only as hearers and cannot use potential situational cues proper. The pragmatics of the study mainly covers different factors which may intervene in the identification and discrimination of the phonological oppositions, other than the linguistic factors proper. The bulk of the pragmatic cues are related to the impressions

given by the meaning, syntax, words and social factors of the test sentences in the discrimination and identification "situations". The term 'linguistic cue' has been reserved for the cues that are deducible from the phonological system and are in many cases explained by linguistic contrastive means.

In the following list, the pragmatic cues are given in the order in which they will be dealt with below:

1. The mastering of the words containing the structures tested.
2. The probability of meeting the words containing the structures tested.
3. The probability of meeting the test sentences.
4. The length of the test sentences.
5. The difficulties of analysing the test sentences.
6. The informational value of the test sentences.
7. The referential appropriateness of the test sentences.
8. The concrete vs. abstract reference of the test sentences.
9. The general vs. situational truth reference of the test sentences.
10. The attitudes and presuppositions towards the messages of the test sentences.
11. The social messages of the test sentences.
12. The person-centred images in the test sentences.
13. Orthographical confusions.
14. Idiolectal variation.
15. The confusion of English and Swedish.

The mastering of the words containing the structures tested is the most common pragmatic cue that affects the identification and perhaps also the discrimination. Poor mastering of the words makes it difficult for the informants to analyse the strings of sounds and to recognize the structures that contain the most essential linguistic cues. This is especially true of junctures because the recognition of words (and the key words in particular) serves as a necessary prerequisite for the detection of the juncture cues proper. Moreover, in the case of segmental phonemes it is easier to pick up identification cues if the respective word is well-mastered. The identification process may sometimes be based on the perception of a word more than on that of an individual phoneme.

The elimination of the word effect is impossible; some words are always better mastered than others. The informants of this study had

studied English for six years and the word effect is clear. In at least 25 cases poor mastering of the key words has lowered the identification percentage of the respective opposition member. Among the poorly mastered words are, for example, *heel, disc, hut, barn, calm, down, goat, pike, swam* and *book-case*, but it is not enough to catalogue these words because their difficulty is relative; the difficulty depends on the point of reference. The poor mastering of a word in one member of an opposition may become especially emphasized if the corresponding word in its opposite member is very well mastered. Thus the word effect is to a large extent opposition-specific.

The high probability of coming across certain words increases their familiarity. Two words may be nearly equally well mastered but one or the other is more popular because of its familiarity. For example, in the pairs *live-leave, ship-sheep, bag-back* and *friends-French* the first members are better identified partly because their occurrence from the point of view of the informants is more probable than that of the second member, though both members are about equally well mastered.

The main reason for the familiarity of the words is their frequent occurrence in school language, ie. in textbooks and classroom activity. In addition, these words are usually among the first English words that the pupils meet at school. Some examples of these words are: *hill, live, ship, bed, cat, bike, bag, coat, name, think* and *friend*. Again, the degree of familiarity depends on which other words they are compared with. When a word is very familiar, its phonological and orthographical structure is well mastered and the picking up of the linguistic cues related to it becomes easier. But the word may also be too familiar, so that the informants tend to hear it even in cases where it is not present.

The probability of the occurrence of the test sentences can direct the discrimination and especially the identification process: certain sentences occur more often in contexts in which the informants are involved. A suitable context speeds up the recognition of the key words (see eg. Tulving and Gold 1966: 326). For example, the first members of the sentence pairs *This is your will/well, isn't it? My pens/pins are not here, His luck/lock is very good, The rubber is on the desk/disc, you see* and *It is a name/an aim* are more probable than the second members. All the sentences are formally acceptable but the situations where they can be met differ considerably. Those having to do with school language are naturally favoured. But some expressions are more probable in the in-

formant's everyday lives, too. They are frequently met in Finnish, which increases their familiarity.

The length of the test sentences also affects discrimination and identification. For example, Hughes and May (1974: 39) state that memory effect is more clearly present in the discrimination between minimal sentence pairs than between minimal word pairs. According to Fry (1970: 49), short term memory capacity limits the information which people can handle in a given time. This may be true for discrimination, but not so much for identification. In the identification process the meaning has a central role, and people can remember meaningful sentences as against unstructured strings (see eg. Slobin 1971: 21; Jauhiainen 1974: 13). As a whole the identification process seems to be based more on the meaning than on the discrimination process. However, if a sentence is very long (eg. *The zoo's luck/lark was a popular talking point. When I was sitting in the boat I started to sink/think* or *It is the biggest tea-pot/teaport in the world*) the picking up of the linguistic cues becomes difficult. To see what the influence sentence length was, the test material was divided into short and long sentences (five words or less vs. more than five words). The mean scores and percentages for both discrimination and identification are given in Table 14.

Table 14. The identification and discriminarion of short and long sentences.

| Sentence length | Discrimination | | | Identification | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | f | $\bar{x}$ | $\bar{x}$% | f | $\bar{x}$ | $\bar{x}$% | $\bar{x}$ | $\bar{x}$% |
| short | 61 | 17.3 | 69.4 | 122 | 14.0 | 55.9 | 15.7 | 62.6 |
| long | 59 | 14.4 | 57.8 | 118 | 12.0 | 48.1 | 13.2 | 52.8 |

The short sentences are identified (mean 55.9%) and discriminated (mean 69.4%) somewhat better than the long sentences (the respective percentages 57.8% and 48.1%). The difference between the short and the long sentences is slightly greater in the discrimination test about 12%) than in the identification test (8%). In general, the short sentences (62,6%) are better identified and discriminated than the long sentences (52,8%). The difficulties in the analysis of the structures of the long

sentences is a probable explanation for the results. However, the differences between short and long sentences are small because many intervening factors blur the picture. For example, the occurrence of stresses on the "critical words" and some idiolectal features distort the result.

The problems in the analysis and recognition of the structure of the sentences can raise identification and discrimination problems. This is especially evident in juncture oppositions like *I know the way to cut it / I know the waiter cut it, I saw the meat / I saw them eat* or *They free Danny / They freed Annie*. The structural relationship between the members is complex in the sense that no one-to-one formal correspondence exists between them. Informants must be able to see what possibilities there are of dividing the segmentally similar sentences into two formally and semantically different units. The sentence stress oppositions relate to underlying structural differences. For example, in *'Flying aeroplanes can be dangerous / Flying 'aeroplanes can be dangerous /* the hearer must realize that the sentence structures are *The aeroplanes that fly are dangerous / To fly aeroplanes is dangerous.* In other words, the sentences consisting of the same phoneme string can have at least these two underlying structures. The problem is especially acute with such pairs as *Have you seen the white 'house? / Have you seen the 'White House?* or *The 'book-case was a special one / The book 'case was a special one*, where it is difficult to know the function of the sentence stress without earlier experience (ie. without knowing, for example, that the stress on *white* implies 'The White House in Washington' and the stress on *house* refers to 'a house painted white'.

The fact that certain forms are preferred influences the identification. For example, in the pair *They are 'playing cards / They are playing 'cards* the informants tend to 'hear' the latter member more readily because they associate these sentences with the present progressive. This is due to the fact that the present progressive is introduced at the beginning of the English studies and the pupils have a strong tendency to use it even in cases where it is not appropriate (see eg. Kohonen and Saleva 1978: 14).

The informational value of the test sentences can be linked up with the identification and discrimination problems. The informational value is like the markedness theory in linguistics (see p. 179 above);

the message carried by a sentence is "unmarked" if it does not give any unusual, new information but "marked" if something new and perhaps unexpected is presented. In other words, for example, driving a car is not a piece of news but driving a car in such a way that an accident takes place is new and informative. In the pair *I picked it up and it really was cold / gold* the latter member is more 'popular' because it is more unexpected and unusual to pick up golden things than to come across something cold. The quite high percentages of the third alternative *It is a shower house* in the case of *It was at our / house / It was a tower house* is obviously related to the interest in something unusual, something that has not, perhaps, even been met before. More or less similar is the popularity of *fox* in the pair *Have you seen the forks / fox there?* In principle, however, the informational value of the sentences differs to a certain extent according to the background of the informants, ie. the informational value of the *gold* sentence is obviously quite small for a goldsmith, for example. Therefore the central determiner of the informational value is to be found in the earlier experience of the world and in its influence on the individuals concerned.

The referential appropriateness of the test sentences affects the perception process. It is important for a language learner to master the sense-relation rules (ie. the relation between form and meaning), but it is also important to be acquainted with the reference-relation rules (see eg. Corder 1973: 103 - 104). The hearer must always be aware of how the sentence meaning relates to the surrounding world, and the concepts about the surrounding world are to a large extent culturally based (Corder 1973: 104).

An example of what is not usually done in a culture is found in the latter member of the pair *They are 'hunting dogs / hunting 'dogs*; it was poorly identified because of it being unusual that dogs are hunted. The knowledge of foreign cultures may also cause reference difficulties. The pair *England is famous for its chips / ships* gathered a lot of *ships* identifications, partly because the pupils know that England is island and it is known for its great seafarers.

The abstract – concrete dimension that the test sentences occupy is in direct relation to the perceptual process. The concrete reference of a sentence is apt to increase the probability that it is chosen in the identification test, in spite of the fact that the thinking process of the informants is no longer based on that of concrete operations (see eg.

Heinonen 1972: 78 - 81; Carroll 1970: 135 - 138). The importance of concreteness for school learning is emphasized for all age groups (see eg. POPS I 1970: 102; Koort 1973: 214 - 215; Ausubel and Robinson 1969: 183 - 190) in such a way that teaching should advance from concrete to abstract because concrete reference is easier to grasp. For example, in the pair *His bid / bed is too high* the second one is more concrete and nearer to the informants' sphere of experience and therefore it better identified. Some other examples in which the concreteness of the first member has gathered more identifications are the following: *It is the biggest tea-pot / teaport in the world. They asked Tom to come / calm down, I picked it up and it really was cold / gold, It was at our house / a tower house* and *His face / faith was not the same as before*. The concreteness – abstractness is naturally not the only pragmatic factor that influences the identification of these pairs; for example, in *cold / gold* the informational value of the sentences plays a role. In general we cannot divide the concrete – abstract dimension into absolute categories. Instead we are concerned with degrees of abstractness or concreteness.

The semantic content of a sentence can also vary according to the truth dimension. Some sentences express general truths, ie. something that is always true, whereas some others refer to occasional truths, ie. a truth that holds only under certain limited conditions. For example, in the pair *The boys spend / spent too much money at weekends* the first member has to do with the general truth that the boys spend a lot of money at certain intervals but the second member only refers to a past period.

The expectancies and presuppositions about the coming message often influence the identification and possibly also the discrimination process. As Bruce (1968: 131) puts it, we hear what we expect to hear. The framework for this kind of phenomenon is provided by the redundancy found in speech. We do not hear the code in its entirety but sample it and make predictions on the basis of our sampling (see eg. Sutherland 1966: 161). Corder (1973: 120) calls this a heuristic model. According to Curney (1973: 96), only 60-80 % of any communication is heard. Therefore knowledge of the context and of the syntactic regularities makes completion and comprehension of a speech sequence possible. At the first stage of language studies in particular the unpredictability of utterances is a source of difficulties. Therefore the learner must attempt to use the

sentence structure and the general setting to get a fair idea of what is to come (see eg. Curney 1973: 98; Lehtonen, Sajavaara and May 1977: 18). Quite often the expectancy errors are due to the extreme familiarity of the key words or of the whole test sentences; the informants identify only the most familiar alternatives, excluding the others. For example, in the pair *It was just a small cut / cot, you see* the third alternative *It was just a small cat, you see* was frequently chosen because of its familiarity, ie. the informants think they hear it despite its clear linguistic difference from the other alternatives. Other pairs whose first members are very familiar and which have been extended to the scope of the other two alternatives are *He has got a bike / pike, Have you seen the colour / collar of my new shirt?*, and *I left my heart / hut in San Francisco*. The low discrimination percentages of the pairs mentioned above (mean solution % 43) may be an indication of the anticipatory effect, ie. the informants tend to 'hear' only the most familiar alternative. Sometimes a centre of interest may lead to an expectancy effect; in the pair *He is interested in sports / spots* the *sports* alternative was popular because of its greater interest for the informants. Generally speaking the expectancy effect is, to some extent, present in the identification of all the test items but in some cases its influence is more marked.

The social content of the sentences is liable to direct the identification process. Certain alternatives may be socially more acceptable than others. The extent and quality of the social explanations seem to be dependent on the informants' age, because the susceptibility to environmental influence is different in various age groups. 14-15-year-old children (like our informants) are especially subject to environmental influence (Heinonen 1972: 170 - 171). They have a tendency to become members of peer groups and to accept its roles and norms. Thus the social values of the peer group may conflict with the values set up by the surrounding society. For example, the high identification percentages of the first members of the pairs *Where is your glass / class. Is your gin / chin strong enough* and the frequent choice of the third alternative *She is looking for her sherry* in case of the pair *She is looking for her cherry / Jerry* reflect the intention to break the taboo connected with the use of alcohol in Finland.

The person-centred image given by the test sentences also influences the identification process. Obviously a reference to people is somehow experienced as more affective than that to various impersonal objects. To some extent this phenomenon may be related to the stage of the informants' social development favourable effect of the person-centred images is seen in the greatly varying identification percentages between the members of the pairs *She is looking for her cherry / Jerry* and *He talked about his chain / Jane*. The occurrence of the proper names quite obviously fortifies the person-centred image. The high identification percentage of *Ted* (88 %) in the pair *The man is Ted / dead* seems to belong to the same category.

A great number of discrimination and identification problems are related to various idiolectal features in the test sample. As Lehtonen, Sajavaara and May (1977: 24) put it, "many elements found in the 'ideal' phonological representation of the message are simplified or deleted, and it is this simplified phonetic chain of utterance that language learners are faced with in a normal communicative situation Though the testing situation of this study does not correspond to a natural communicative situation and therefore various pragmatic features like gestures and facial expressions are not available, some other idiolectal features ensure that the test sample is not an ideal representation of speech as described in textbooks. Factors such as speaking rate, tempo, rhythm, loudness, linking, assimilation and reduction make the linguistic cues of each particular opposition prominent or less prominent (see eg. Lehtonen, Sajavaara and May 1977: 24; Gimson 1966: 3 - 4). The juncture cues in particular are subject to idiolectal variation to such an extent that they may even become neutralized.

The most overt and frequent idiolectal factor in this study is the placement of the sentence stress on the key words, ie. the words containing the main linguistic identification and discrimination cues. (No predetermined stress pattern was provided (except in the case of sentence stress oppositions) and no situational reference was presented to the speaker of the test material.) When the sentence stress happened to fall on the key words, the perceptual process was facilitated whereas the lack of the sentence stress on the 'critical' words had a contrary effect. The mean discrimination and identification percentages of the pairs that lacked the 'critical' sentence stress (ie. *cut-cot, hut-heart, come-calm, peach-beach, spent-spend, cold-gold, trips-drips* and *way to-waiter*) are 51.5 %

and 41.5 % whereas the respective figures for the entire tests are 64.4% and 51.5 %. Thus both discrimination and identification problems seem to be related to the presence or absence of sentence stress on the key words. The lack of sentence stress also causes various reduction phenomena, which naturally weaken the linguistic cues in question. Another factor that contributes to the picking up of linguistic cues is the overall "carefulness" of the pronunciation in the test samples. For example, in the pair *princess – prince S* the difference between the members was emphasized and nearly all the informants (96 %) perceived this distinction. No such effect was present in the pair *try – dry* and the perception of the difference was very difficult (16 %).

The effect of Swedish on discrimination and identification is not very extensive in this study but it is important as a potential cue, because the informants had studied Swedish as their second foreign language for three years. Firstly, Swedish influence is apparent in the perception of the opposition /ʃ/ - /tʃ/. In Swedish the corresponding sounds [ʃ] and [tʃ] are in free variation (see eg. Stubelius 1969: 90). Secondly, in the identification test the word *lock* was confused with the Swedish word *lock*, which means 'shutter'. The identification has taken place on the basis of the formal correspondence between these words, and therefore the hypothesis that Finnish speakers use the spelling as a point of reference gets more support.

The pragmatic cues can be divided into various categories, for example, syntactic, semantic, orthographical, social, psychological, etc., but the common denominator for all these factors is the degree of familiarity of the different structures present in the test sentences. The familiarity may be related to words, sentences, orthography, meaning or social context of the test items. It is difficult to estimate the relative importance of the linguistic and pragmatic cues because their importance varies from context to context. The influence of the linguistic cues is strongly related to the idiolect of the test sample. Even though the pragmatic cues in one form or another are nearly always present, their effect is emphasized if the linguistic cues are weak, which does not, of course, mean that the test sample is badly pronounced. As a whole the pragmatic cues reported in this study are only the tip of the "iceberg" that is found in a natural speech situation.

Discrimination and identification tests and pronunciation skills. — This section will deal with the applicability of the perceptual tests used in this study to the measuring of the pronunciation skills.

The comparison of the discrimination and identification skills is here carried out by means of the correlation matrix presented in Figure 5. The discrimination and identification test results have been correlated with each other and with certain background variables. Among these background variables the mean of the marks in all the school subjects indicates the general success at school. The school marks in English show the English skills. The mark in music has been included, because an aptitude for music may, to some extent, be connected with the discrimination and identification skills. The production variable (= P) consists of the results of the production test.

| | E | M | MN | D | I | V | P |
|---|---|---|---|---|---|---|---|
| E | 1.00 | | | | | | |
| M | 0.27 | 1.00 | | | | | |
| MN | 0.76 | 0.29 | 1.00 | | | | |
| D | 0.22 | 0.15 | 0.41 | 1.00 | | | |
| I | 0.67 | 0.39 | 0.60 | 0.29 | 1.00 | | |
| V | 0.52 | 0.52 | 0.57 | 0.02 | 0.42 | 1.00 | |
| P | 0.65 | 0.44 | 0.77 | 0.26 | 0.70 | 0.49 | 1.00 |

Figure 5. The intercorrelations computed between the tests used in this study and certain background variables. The variables are as follows: E = marks in English, M = marks in music, MN = mean marks in all school subjects, D = scores in the discrimination test, I = scores in the identification test, V = scores in the vocabulary test and P = scores in the production test.

The correlations are not high (all less than 0.80). This is partly due to the fact that the tests were primarily designed for the study of the discrimination and identification of certain phonological oppositions, while the measuring of the pronunciation skills was only a secondary aim. For instance no pretesting was carried out. Another factor lowering the correlation coefficients is the quite small scatter of the scores within both perceptual tests, the discrimination test scores ranging from 30 to 40 (maximum 60) and the identification scores from 52 to 97 with one

expection (maximum 120). The corresponding figures for the vocabulary test are 87 to 127 (maximum 131) (see Appendix 2). The small variations tend to lower the correlation coefficients (see eg. Peltonen 1970: 44; Koponen 1976: 28).

The correlation between the identification and discrimination test is quite low, 0.29, which shows that there is no great correspondence between them. Obviously they measure different skills. From a psycholinguistic point of view the situation can be illustrated by Corder's model of the receptive skills (1973: 117 - 124), which is presented in the form of a schema in Figure 6.

Figure 6. Receptive activities from a psycholinguistic point of view according to Corder (1973: 117 - 124).

All the skills (discrimination, recognition, identification and understanding) presented in Figure 8 are necessary for the understanding of an FL message. The skills are hierarchically ordered in such a way that identification activity, for example, presupposes recognition and discrimination skills.

The discrimination test used in this study can be seen as an equivalent to the discrimination activity in Figure 8. It presupposes auditory skills only, ie. the listener must be able to 'hear' certain sound phenomena (like the degrees of intensity, pitch, duration and quality) as distinct from each other. The discrimination process is therefore a passive activity because 'hearing is not doing anything - it is just something that happens to you' (Corder 1973: 117). Naturally the making of a distinction between various sound phenomena presupposes some concentration but no cognitive skills are needed, The discriminatory skills are not specifically linguistic, because they are needed in making sense of the 'world of sounds' in general.

The identification test in this study contains all the activities mentioned in Corder's hierarchy. The starting point is the discriminatory

skill. For addition, the listener must possess the recognition skills, ie. he must be able to put the incoming data into the schema that he has acquired by means of intuition and experience of language in general. The listener has internalized certain hypotheses against which he tests the incoming perceptions and locates the sensations he receives in the abstract model called 'perceptual schemata' (see eg. Corder 1973: 118). For example, the recognition of an FL segmental phoneme means that we are able to classify it, ie. to match the input data with stored representations. Therefore recognition is an active cognitive process which has at least something to do with problem solving ability (see eg. Gregory 1970: 30).

At the word and word-group level the incoming data can be compared with the stored schemata but at the sentence level this is not possible, because all the sentences hear have no equivalents in the models we have stored earlier. Instead we have stored a limited number of rules governing various sentence structures. Every sentence is analysed at the identification phase. According to Corder (1973: 120), this is done heuristically, ie. by predicting the structure of the utterance concerned by means of sampling.

Finally, the listener must be able to understand the message he receives in its particular context and in this way realize the communicative intent of the speaker. This skill, (not far from) pragmatics, is called understanding in Corder's model. Because the identification test in this study presupposes, not only the discrimination and recognition of phonological structures, but also the identification and understanding of the test sentences, it comprises roughly speaking all the skills in the hierarchy above and is, contrary to the discrimination test, a strongly cognitive activity. This becomes evident in the way in which the discrimination and identification tests correlate to the other variables in this study (see Figure 7).

Firstly, the identification test correlates better to the apparently cognitive English skills (0.69) than does the discrimination test (0.22). The situation is the same with aptitude for music (0.39 for identification and 0.15 for discrimination). In the light of Corder's model aptitude for music presupposes at least some kind of recognition activity. General school achievement correlates better with the identification test (0.66) than with the discrimination test (0.14). The vocabulary test that

presupposes some cognitive mastering of English does not correlate with the discrimination test (0.02) at all but to some extent with the identification test (0.42). Thus the mastering of the vocabulary of the structures tested is not of great importance in the discrimination process, which supports the view that the discrimination test measures hearing ability, even though the detailed study of the test items showed that the familiarity of the key words made it difficult to perceive certain distinctions. Some informants may have used the 'probable' meaning of the words and sentences as their perceptual strategy. In addition, the production test correlates better with the identification test (0.70) than with the discrimination test (0.26). The productive test is cognitive in the sense that the informants must know the relationship between English orthography and its phonological and phonetic representation.

The above results are supported by the findings of Moisio and Valento (1976: 82). Because the discrimination test measured hearing ability only, such variables as language skills and attitudes towards English did not correlate as strongly with the discrimination test as with the analogy tests. Further, Moisio and Valento (1976: 85) found that learners of German got as equally high scores in the discrimination test as learners of English and that the background variables which were not concerned with language skills proper correlated better with the discrimination test than with language-skill variables. In Hirvonen's study (1971: 34), too, the correlations between the discrimination and the identification tests were quite low. Lehtonen and Koponen (1977: 84) report a correlation of 0.52 between the mark in English and the linking of words.

That the discrimination test is relatively easier (solving % 64.4) than the identification test (solving % 51.5) probably reflects the mechanical nature of the discrimination test and the cognitiveness of the identification test (see Appendix 2). The same tendency was apparent in Moisio and Valento's (1976: 86) study, where the solving percentage for the discrimination test was 74.3 % and for the analogy tests 53.4 and 57.3.

The results show that the identification test presupposes more complicated cognitive processes than the discrimination test, which could perhaps be replaced by a test measuring the discrimination of various sounds and noises which have nothing to do with linguistic distinctions. Thus the identification test clearly measures language

skills (= the mastering of the FL), whereas the discrimination test measures hearing ability only. According to Lehtonen (1972a: 21), a speaker with normal hearing can, at least after some exercise, discriminate between various FL sounds in the same way as he discriminates between various colours. But in FL learning this is not enough. The learner must also be able to identify the FL sounds and to realize that certain new phonetic cues may completely change the meaning of the utterance in question. In other words, the discrimination test does not necessarily measure the mastering of the foreign language sound system (see eg. Lehtonen 1972b: 18).

The scope of the tests can also be looked at from a linguistic point of view, ie. to find out what linguistic levels (phonology, syntax, semantics) they have to do with. The discrimination test is related to the phonological level only, but it does not even cover the phonology as a whole. The identification test consists of phonological, syntactic and semantic component. This is probably one reason for the claim that a test based on minimal pair sentences measures syntactic and semantic skills only (see eg. Tommola 1975: 13). However, the mastering of the phonological system is integrally related to the mastering of the skills presupposed by the other linguistic levels. For example, the linking of words and the introduction of pauses in sentences presuppose the mastering of syntax as well as the understanding of the functions of junctures and sentence stress. The grouping of the sounds into phonemes is based on semantic principles (see eg. Lehtonen 1972a: 51; Mackey 1971: 80). Further, the mastering of vocabulary may make the identification of individual phonemes easier in the same way as the understanding of phonological rules does. However, the identification result is not fully predictable by means of the mastering of the key words because the correlation between the identification test and the vocabulary test is only 0.42. Some other factors like the redundancy with its expectancy function, social preference, informative value, or familiarity interfere with the mastering of the sound system. Therefore the linguistic levels should also include pragmatics (Lehtonen, Sajavaara and May 1977: 180). The mastering of the sound system is not a mere sum of the phonological distinctions and identification cues; its connections with the skills at the other levels of language are quite obvious. Thus, for example, the importance of the individual phonemes in sentences or in natural speech is

relatively small, because they can be predicted by means of cues other than specifically phonological (phonetic) ones.

The identification test contains a certain number of skills related to communicative competence though it is not concerned with an interaction process proper between the speaker and the hearer, while the discrimination test has no strong connections with communicative competence. The discrimination test procedure can be described by means of Corder's (1973: 359) model presented in Figure 7.

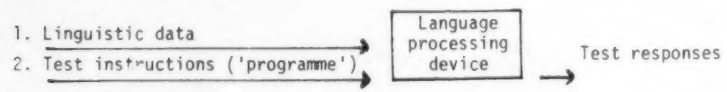



Figure 7. The discrimination test procedure.

According to this model the input consists of the linguistic data and the test instructions that are handled by the language processing device of the learner and the result (= output) is the test responses. The data in the discrimination test passes through the language processing device without being influenced by other factors. The situation is different in the identification test, which can be illustrated by Corder's (1973: 363) model of a test measuring communicative competence (Figure 8).

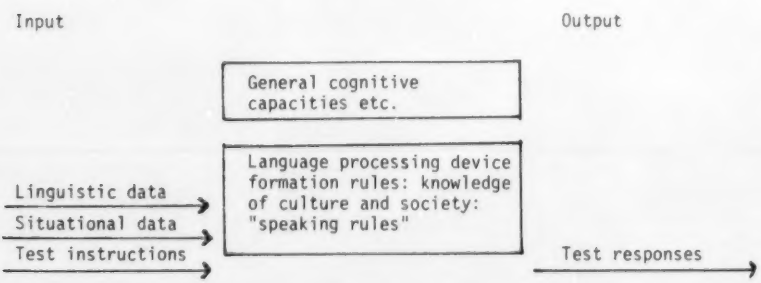



Figure 8. The identification test procedure.

The input data consists of the linguistic data (= the phonological oppositions) and the situational data (= in this case, various pragmatic factors and the test instructions). The language processing device

contains the learner's linguistic competence (= formation rules) and performance (= speaking rules) together with the influence of the general cognitive capacities. The result of the processing of the input data is the test responses. Thus the identification test has to do with cognitive skills and with communicative competence (although the pragmatic cues cover only some of those present in natural speech). It also has links with knowledge of society and culture in general. The discrimination test, however, lacks these components.

The relationship between the discrimination and identification tests and the productive skills is an interesting problem. There is a consensus of opinion on the fact that the receptive and productive processes are related to each other (see eg. Carroll 1970: 64; Wängler and Weiss 1975: 196; Corder 1973: 125). For example, the auditory feedback is needed in the production process for the control of the articulatory movements. However, it is obvious that the receptive and productive processes do not completely correspond to each other. According to Lehtonen, Sajavaara and May (1977: 18 - 19), a complete correspondence would mean that the "interpretation of the message takes place after the hearer has received the acoustic cues contained in the surface form of the message". The native speaker, however, uses his ability to predict, and the perception takes place by means of all the available linguistic and non-linguistic cues. Therefore, neither the receptive process nor the productive one are based on the 'ideal' surface representation of speech: many intervening factors complicate these processes (see. eg. Corder 1973: 123).

The results of this study show that the connection between the receptive and productive skills depends on what kind of processes these skills presuppose. The identification test measuring integrative and cognitive skills correlates better with the production test (0.70) than with the discrimination test primarily measuring mechanical auditory skills (0.25). Thus the ability to discriminate does not necessarily imply any productive skills (see also van Teslaar 1965: 88; Tommola 1975: 6). The strong correlation between the identification and production tests may be due to the fact that both tests presuppose some cognitive and integrative skills. An indication of the cognitive and integrative nature of the productive skills is the high correlation (0.65) between the identification test and the English marks. Further, the correlations between the identification test and Swedish marks (0.77),

music (0.43) and general school achievement (0.77) are quite high. The high correlations between the productive and receptive skills obtained by Munsell (1973: 46, 54, 103) and Kjellmer (1968: 138 - 139), 0.78 and 0.58 respectively, are obviously explainable by the same kind of reasoning as lies behind the high correlations of this study.

The low correlations between the discrimination test and the production skills are probably due to the fact that no parallel exists between reception and production in regard to cognitive piocesses. Thus if we need a receptive test capable of predicting the production skills through which the message in the orthographical form will be translated into speech, we must construct a test similar to the identification test used in this study; it must consist of the various cues necessary in the interpretation of the message (cues related to phonology, morphology, syntax, semantics and pragmatics) (see eg. Kohonen 1976: 39; Tommola 1977: 25 - 26; Pilliner 1977: 14; Kohonen and Saleva 1978: 18). It is impossible to say if reception is a precondition for production, or the other way round, or whether the relationship between these skills is interactive. However, an awareness of all the factors influencing the understanding and production of a message is necessary for an FL learner.

The correlation between aptitude for music and the other variables varies a lot; between it and the mark in English (0.27), general school achievement (0.29) and the discrimination test (0.15) the correlations are quite low. Between it and the identification test (0.39) production test (0.44) and vocabulary test they are however somewhat higher (0.52). Lehtonen and Koponen (1977: 84) got a correlation of 0.48 between aptitude for music and the preference for linking. In Lehtovaara's (1974: 50) study, aptitude for music was better correlated with the linking of sounds (0.32) and intonation (0.35) than with discrimination (0.06). So it seems that aptitude for music is not very strongly related to discrimination but somewhat better to the variables having to do with skills of a more cognitive native. On the other hand, general cognitive capacities like school achievement do not get very high correlations. Therefore we can assume that aptitude for music is related to the same area of the communicative process as the phonetic identification cues, ie. the use of the phonetic cues has something to do with aptitude for music.

CONCLUSIONS

The great number of factors influencing the receptive pronunciation skills reflects the complex nature of these skills. We are not only concerned with interpreting the phonetic surface structure of an FL utterance but we are supposed to have an ability to cope with all the factors present in a particular reception situation.

It is, however, impossible to say which kinds of factors are more important, phonetic or pragmatic. We may only assume that the use of the phonetic identification cues is greatest at the beginning of FL learning and that their importance decreases when the studies advance, while the importance of pragmatic cues increases. It may also be that when the speech situation becomes more natural, the use of pragmatic cues increases. Therefore, tests that measure the mastering of phonetic cues are not comprehensive enough, even though the phonetic factors as such may constitute an important source of receptive difficulties.

The use of the pragmatic cues in the perceptual process presupposes the learner's ability to operate on both the syntactic and the morphological level; operations with the phonetic surface structure should be so far automatized that the learner need not consciously concentrate on the picking up of the information it carries. The reception should be based on sampling and on the use of the redundancy present in speech.

From the language teaching point of view what is essential is how these receptive skills can be developed. All the factors playing a role in the receptive process should be taken into account. The materials should consist of many varieties of the FL, so that the interpretation of the phonetic cues would become unconscious and automatic. The interpretation of the message should be based on morphological, syntactic, semantic and pragmatic cues. Moreover, the cognitive and communicative nature of language learning should be emphasized. The lack of attention to cognitive skills can be seen, among other things, in the introduction of the direct and audiolingual methods; for example, in a pilot study by the present writer the number of cognitive techniques used in teaching pronunciation and semantics amounted to only 28 % of all the methods used.

At present, the teaching of English pronunciation cannot be satisfactorily carried out in Finnish comprehensive schools. During the first three years, when the teaching of pronunciation could be appropriate because of the pupils' good ability in sound perception and imitation,

the groups to be taught are too big or, especially in the country, are composed of two groups at different levels (eg. the fifth and sixth forms) are taught simultaneously. If the time available for efficient teaching is about 20 minutes twice a week some grammar and vocabulary should also be dealt with, the teaching of pronunciation remains minimal. At the beginning of language studies, listening exercises would be important, but the pupils cannot concentrate on mere listening, because they want to express themselves in the foreign language. Thus, although the language learning process would be promoted by listening exercises, various pedagogic reasons do not always favour this.

At the later stages of English studies the problems are related to big teaching groups, to the small number of English lessons and to the lack of teaching aids.

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APPENDIX 1. The material of the present study.

1. I feel it now.
   I fill it now.
2. The heel is very high.
   The hill is very high.
3. He wanted to leave.
   He wanted to live.
4. I saw the sheep there.
   I saw the ship there.
5. This is your will, isn't it?
   This is your well, isn't it?
6. The rubber is on the disc, you see.
   The rubber is on the desk, you see.
7. My pins are not here.
   My pens are not here.
8. His bid is too high.
   His bed is too high.
9. It is the biggest tea-pot in the world.
   It is the biggest tea-port in the world.
10. He is interested in spots.
    He is interested in sports.
11. Have you seen the fox there?
    Have you seen the forks there?
12. It was just a small cot, you see.
    It was just a small cut, you see.
13. Have you seen the collar of my new shirt?
    Have you seen the colour of my new shirt?
14. His lock is very good.
    His luck is very good.
15. The bun is too big.
    The barn is too big.
16. I left my hut in San Francisco.
    I left my heart in San Francisco.
17. We asked Tom to come down.
    We asked Tom to calm down.
18. The zoo's luck was a popular talking point.
    The zoo's lark was a popular talking point.
19. Look at those peas in your garden!
    Look at those bees in your garden!
20. John liked the peach very much.
    John liked the beach very much.
21. He has got a pike.
    He has got a bike.

22. The man is Ted.
    The man is dead.

23. He used to write when he was young.
    He used to ride when he was young.

24. They built the house very well.
    They build the house very well.

25. The boys spent too much money at weekends.
    The boys spend too much money at weekends.

26. You've got writings on your back, haven't you?
    You've got writings on your bag, haven't you?

27. I picked it up and it really was cold.
    I picked it up and it really was gold.

28. His coat is very old.
    His goat is very old.

29. Where is your class?
    Where is your glass?

30. She is looking for her cherry.
    She is looking for her Jerry.

31. He talked about his chain.
    He talked about his Jane.

32. Is your chin strong enough?
    Is your gin strong enough?

33. Let's try it.
    Let's dry it.

34. John liked the trips very much.
    John liked the drips very much.

35. When I was sitting in the boat I started to sink.
    When I was sitting in the boat I started to think.

36. He has not got the same face as before.
    He has not got the same faith as before.

37. He is washing the baby.
    He is watching the baby.

38. England is famous for its ships.
    England is famous for its chips.

39. Tom doesn't understand his friends at all.
    Tom doesn't understand his French at all.

40. His tulips are red.
    His two lips are red.

41. I saw the meat.
    I saw them eat.

42. They have got peace talks there.
    They have got pea stalks there.

43. That princess is our friend.
    That prince S is our friend.

44. I know the way to cut it.
    I know the waiter cut it.

45. Her doll has got a grey tie.
    Her doll has got a great eye.

46. It was at our house.
    It was a tower house.

47. This nitrate is expensive nowadays.
    This night-rate is expensive nowadays.

48. That's our milk.
    That's sour milk.

49. It is a name.
    It is an aim.

50. They free Danny.
    They freed Annie.

51. I've got twenty-six ones.
    I've got twenty sick swans.

52. My newer dress is here.
    My new address is here.

53. Have you seen the 'White House?
    Have you seen the white 'house?

54. 'Flying aeroplanes can be dangerous.
    Flying 'aeroplanes can be dangerous.

55. John gave her dog 'biscuits.
    John gave her 'dog biscuits.

56. They are 'hunting dogs.
    They are hunting 'dogs.

57. The 'book-case was a special one.
    The book 'case was a special one.

58. 'Visiting friends can ve dangerous.
    Visiting 'friends can be dangerous.

59. They are 'playing cards.
    They are playing 'cards.

60. They are 'frying chickens.
    They are frying 'chickens.

APPENDIX 2. The scores achieved by the informants in the discrimination, identification, vocabulary and production tests together with the subjects' background information. The symbols used in the table are as follows: D stands for the discrimination, I for the identification, V for the vocabulary and P for the production test. MN, E and M give the informants' mean for all the school subjects, their mark in English and their mark in music.

| Informant no | Tests | | | | School marks | | |
|---|---|---|---|---|---|---|---|
| | D | I | V | P | MN | E | M |
| 1 | 39 | 54 | 109 | 7 | 5.7 | 5 | 8 |
| 2 | 37 | 60 | 89 | 4 | 6.5 | 5 | 8 |
| 3 | 41 | 69 | 115 | 5 | 6.7 | 9 | 8 |
| 4 | 41 | 59 | 101 | 7 | 7.6 | 8 | 5 |
| 5 | 43 | 69 | 106 | 12 | 7.6 | 7 | 8 |
| 6 | 36 | 70 | 106 | 9 | 7.8 | 8 | 8 |
| 7 | 43 | 63 | 111 | 10 | 7.7 | 8 | 9 |
| 8 | 36 | 62 | 991 | 8 | 8.1 | 7 | 5 |
| 9 | 44 | 97 | 127 | 14 | 8.8 | 9 | 9 |
| 10 | 31 | 67 | 111 | 8 | 7.3 | 8 | 9 |
| 11 | 46 | 72 | 108 | 9 | 8.5 | 9 | 9 |
| 12 | 33 | 69 | 119 | 10 | 8.3 | 7 | 8 |
| 13 | 35 | 67 | 109 | 14 | 8.2 | 8 | 9 |
| 14 | 40 | 74 | 111 | 15 | 8.7 | 9 | 9 |
| 15 | 33 | 47 | 377 | 6 | 6.7 | 6 | 7 |
| 16 | 39 | 75 | 115 | 11 | 8.3 | 8 | 8 |
| 17 | 38 | 62 | 67 | 6 | 5.7 | 6 | 6 |
| 18 | 36 | 52 | 95 | 7 | 6.5 | 5 | 8 |
| 19 | 49 | 58 | 64 | 7 | 7.1 | 7 | 7 |
| 20 | 45 | 74 | 115 | 11 | 8.3 | 8 | 8 |
| 21 | 30 | 73 | 103 | 8 | 7.8 | 8 | 7 |
| 22 | 38 | 53 | 105 | 11 | 7.9 | 9 | 7 |
| 23 | 47 | 60 | 107 | 9 | 7.3 | 7 | 8 |
| 24 | 35 | 60 | 98 | 4 | 7.0 | 6 | 8 |
| 25 | 36 | 37 | 106 | 3 | 6.6 | 5 | 7 |
| Maximum | 60 | 120 | 131 | 15 | 10 | 10 | 10 |
| Mean score | 38.3 | 64.1 | 103.0 | 8.6 | 7.47 | 7.28 | 7.72 |
| Stdev | 5.02 | 11.51 | 14.59 | 3.19 | 0.87 | 1.37 | 1.14 |

APPENDIX 3. The results of the discrimination, identification and vocabulary tests. The letters IT stand for the item tested. D stands for the discrimination test results divided into: DN, the number of the item in question on the answer sheet; DFC, the frequency of correct answers; and DPC, the percentage of correct answers. I stands for the identification test results, the subgroups being IN (= the number of the item on the answer sheet), IPC (= the frequency of correct answers), IFO (= the frequency of answers gathered by the opposite member), IFT (= the frequency of answers gathered by distractor alternative), IPC (= the percentage of correct answers), IPO (= the percentage of the answers gathered by the opposite member), IPT (= the percentage of answers got by the distractor alternative). The letter V stands for the vocabulary test results and is divided into VFC (= the frequency of correct answers in vocabulary test), VPC (= the percentage of the correct answers). The letters PT stand for the mean percentage of the correct answers in all the tests (ie. the discrimination + identification + vocabulary test) in the case of each item.



| IT | D | | | I | | | | | | | V | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| fill | 6 | 20 | 80 | 7 | 8 | 14 | 3 | 32 | 56 | 12 | 18 | 72 | 61.33 |
| feel | 6 | 20 | 80 | 24 | 18 | 6 | 1 | 72 | 24 | 4 | 24 | 96 | 82.67 |
| hill | 9 | 16 | 64 | 34 | 19 | 2 | 4 | 76 | 8 | 16 | 23 | 92 | 77.33 |
| heel | 9 | 16 | 64 | 13 | 6 | 19 | 0 | 24 | 76 | 0 | 13 | 52 | 46.67 |
| live | 11 | 22 | 88 | 18 | 16 | 5 | 4 | 64 | 20 | 16 | 23 | 92 | 81.33 |
| leave | 11 | 22 | 88 | 21 | 13 | 12 | 0 | 52 | 48 | 0 | 21 | 84 | 74.67 |

| IT | D | | | I | | | | | | V | | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| ship | 17 | 18 | 72 | 29 | 17 | 4 | 4 | 68 | 16 | 16 | 25 | 100 | 80.00 |
| sheep | 17 | 18 | 72 | 33 | 19 | 5 | 1 | 76 | 20 | 4 | 23 | 92 | 80.00 |
| will | 8 | 21 | 84 | 14 | 19 | 5 | 1 | 76 | 20 | 4 | 21 | 84 | 81.33 |
| well | 8 | 21 | 84 | 10 | 5 | 17 | 3 | 20 | 68 | 12 | 9 | 36 | 46.67 |
| disc | 10 | 16 | 64 | 15 | 0 | 22 | 3 | 0 | 88 | 12 | 0 | 0 | 21.33 |
| desk | 10 | 16 | 64 | 17 | 20 | 0 | 5 | 80 | 0 | 20 | 24 | 96 | 80.00 |
| pins | 5 | 14 | 56 | 8 | 1 | 17 | 7 | 4 | 68 | 28 | 20 | 80 | 46.67 |
| pens | 5 | 14 | 56 | 5 | 22 | 1 | 2 | 88 | 4 | 8 | 19 | 76 | 73.33 |
| bid | 7 | 22 | 88 | 9 | 13 | 8 | 4 | 52 | 32 | 16 | 7 | 28 | 56.00 |
| bed | 7 | 22 | 88 | 12 | 21 | 2 | 2 | 84 | 8 | 8 | 24 | 96 | 89.33 |
| tea-pot | 3 | 16 | 64 | 11 | 15 | 8 | 2 | 60 | 32 | 8 | 23 | 92 | 72.00 |
| tea-port | 3 | 16 | 64 | 3 | 4 | 20 | 1 | 16 | 80 | 4 | 14 | 56 | 45.33 |
| spots | 4 | 21 | 24 | 4 | 2 | 17 | 6 | 8 | 68 | 24 | 16 | 64 | 52.00 |
| sports | 4 | 21 | 84 | 16 | 22 | 1 | 2 | 88 | 4 | 8 | 22 | 88 | 86.67 |
| fox | 12 | 12 | 48 | 22 | 20 | 4 | 1 | 80 | 16 | 4 | 25 | 100 | 76.00 |
| forks | 12 | 12 | 48 | 19 | 9 | 16 | 0 | 36 | 64 | 0 | 19 | 76 | 53.33 |

| IT | D | | | I | | | | | | V | | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFD | IFT | IPC | IPO | IPT | VFC | VPC | |
| cot | 2 | 10 | 40 | 2 | 9 | 5 | 10 | 36 | 24 | 40 | 13 | 52 | 42.67 |
| cut | 2 | 10 | 40 | 6 | 4 | 9 | 12 | 16 | 36 | 48 | 22 | 88 | 48.00 |
| collar | 16 | 10 | 40 | 28 | 4 | 21 | 0 | 16 | 84 | 0 | 7 | 28 | 28.00 |
| colour | 16 | 10 | 40 | 31 | 22 | 2 | 1 | 88 | 8 | 4 | 24 | 96 | 74.67 |
| lock | 18 | 24 | 96 | 36 | 13 | 9 | 3 | 52 | 36 | 12 | 16 | 64 | 70.67 |
| luck | 18 | 24 | 96 | 32 | 23 | 2 | 0 | 92 | 8 | 0 | 22 | 88 | 92.00 |
| bun | 1 | 22 | 88 | 1 | 5 | 2 | 18 | 20 | 8 | 72 | 19 | 76 | 61.33 |
| barn | 1 | 22 | 88 | 35 | 2 | 9 | 14 | 8 | 36 | 56 | 8 | 32 | 42.67 |
| hut | 13 | 12 | 48 | 23 | 1 | 19 | 5 | 4 | 76 | 20 | 4 | 16 | 22.67 |
| heart | 13 | 12 | 48 | 20 | 22 | 0 | 3 | 88 | 0 | 12 | 21 | 84 | 73.33 |
| come | 14 | 17 | 68 | 25 | 23 | 0 | 2 | 92 | 0 | 8 | 120 | 100 | 86.67 |
| calm | 14 | 17 | 68 | 27 | 2 | 21 | 2 | 8 | 84 | 8 | 6 | 24 | 33.33 |
| luck | 15 | 13 | 52 | 26 | 10 | 3 | 12 | 40 | 12 | 48 | 22 | 88 | 60.00 |
| lark | 15 | 13 | 52 | 30 | 1 | 110 | 14 | 4 | 40 | 56 | 21 | 84 | 46.67 |
| peas | 41 | 11 | 44 | 79 | 17 | 3 | 5 | 68 | 12 | 20 | 17 | 68 | 60.00 |
| bees | 41 | 11 | 44 | 83 | 13 | 11 | 1 | 52 | 44 | 4 | 8 | 32 | 42.67 |
| peach | 46 | 14 | 56 | 90 | 11 | 11 | 3 | 44 | 44 | 12 | 21 | 84 | 61.33 |
| beach | 46 | 14 | 56 | 86 | 15 | 18 | 2 | 20 | 72 | 8 | 18 | 72 | 49.33 |
| pike | 54 | 11 | 44 | 96 | 2 | 23 | 0 | 8 | 92 | 0 | 9 | 36 | 29.33 |
| bike | 54 | 11 | 44 | 100 | 23 | 1 | 1 | 92 | 4 | 4 | 25 | 100 | 78.67 |
| Ted | 43 | 21 | 84 | 116 | 22 | 3 | 0 | 88 | 12 | 0 | - | - | 86.00 |
| dead | 43 | 21 | 84 | 81 | 22 | 2 | 1 | 88 | 8 | 4 | 23 | 92 | 88.00 |
| write | 42 | 13 | 52 | 80 | 12 | 12 | 1 | 48 | 48 | 4 | 25 | 100 | 66.67 |
| ride | 42 | 13 | 52 | 115 | 14 | 9 | 2 | 56 | 36 | 8 | 25 | 100 | 69.33 |

| IT | D | | | I | | | | | | V | | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| built | 45 | 20 | 80 | 117 | 15 | 8 | 2 | 60 | 32 | 8 | 22 | 88 | 76.00 |
| build | 45 | 20 | 80 | 85 | 5 | 13 | 7 | 20 | 52 | 28 | 22 | 88 | 62.67 |
| spent | 47 | 10 | 40 | 119 | 8 | 15 | 2 | 32 | 60 | 8 | 23 | 92 | 54.67 |
| spend | 47 | 10 | 40 | 87 | 13 | 11 | 1 | 52 | 44 | 4 | 23 | 92 | 61.33 |
| back | 49 | 22 | 88 | 91 | 8 | 15 | 2 | 32 | 60 | 8 | 23 | 92 | 70.67 |
| bag | 49 | 22 | 88 | 111 | 20 | 5 | 0 | 80 | 20 | 0 | 25 | 100 | 89.33 |
| cold | 58 | 19 | 76 | 107 | 14 | 10 | 1 | 56 | 40 | 4 | 25 | 100 | 77.33 |
| gold | 58 | 19 | 76 | 103 | 19 | 6 | 0 | 76 | 24 | 0 | 25 | 100 | 84.00 |
| coat | 59 | 10 | 40 | 106 | 23 | 2 | 0 | 92 | 8 | 0 | 25 | 100 | 77.33 |
| goat | 59 | 10 | 40 | 109 | 8 | 16 | 1 | 32 | 64 | 4 | 17 | 68 | 46.67 |
| class | 60 | 20 | 80 | 112 | 10 | 15 | 0 | 40 | 60 | 0 | 13 | 52 | 57.33 |
| glass | 60 | 20 | 80 | 122 | 14 | 9 | 2 | 56 | 36 | 8 | 25 | 100 | 68.67 |
| cherry | 53 | 14 | 56 | 95 | 6 | 15 | 4 | 24 | 60 | 16 | 20 | 80 | 53.33 |
| Jerry | 53 | 14 | 56 | 104 | 21 | 1 | 3 | 84 | 4 | 12 | - | - | 70.00 |
| chain | 55 | 14 | 56 | 102 | 3 | 22 | 0 | 12 | 88 | 0 | 15 | 60 | 42.67 |
| Jane | 55 | 14 | 56 | 98 | 23 | 0 | 2 | 92 | 0 | 8 | - | - | 74.00 |
| chin | 56 | 22 | 88 | 99 | 7 | 18 | 0 | 28 | 72 | 0 | 12 | 48 | 54.67 |
| gin | 56 | 22 | 88 | 105 | 18 | 4 | 3 | 72 | 16 | 12 | 19 | 76 | 78.67 |
| try | 48 | 4 | 16 | 89 | 22 | 3 | 0 | 88 | 12 | 0 | 23 | 92 | 65.33 |
| dry | 48 | 4 | 16 | 118 | 10 | 15 | 0 | 40 | 60 | 0 | 22 | 88 | 48.00 |
| trips | 50 | 12 | 48 | 92 | 0 | 10 | 15 | 0 | 40 | 60 | 21 | 84 | 44.00 |
| drips | 50 | 12 | 48 | 110 | 10 | 14 | 1 | 40 | 56 | 4 | 15 | 60 | 49.33 |
| sink | 44 | 18 | 72 | 88 | 17 | 4 | 4 | 68 | 16 | 16 | 10 | 40 | 60.00 |
| think | 44 | 18 | 72 | 84 | 24 | 1 | 0 | 96 | 4 | 0 | 24 | 96 | 88.00 |

| IT | D | | | I | | | | | | | V | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| face | 52 | 15 | 60 | 94 | 20 | 2 | 3 | 80 | 8 | 12 | 25 | 100 | 80.00 |
| faith | 52 | 15 | 60 | 97 | 5 | 14 | 6 | 20 | 56 | 24 | 9 | 36 | 38.67 |
| washing | 51 | 23 | 92 | 114 | 24 | 1 | 0 | 96 | 4 | 0 | 23 | 92 | 93.33 |
| watching | 51 | 23 | 92 | 93 | 17 | 3 | 5 | 68 | 12 | 20 | 24 | 96 | 85.33 |
| ships | 57 | 10 | 40 | 113 | 17 | 6 | 2 | 68 | 24 | 8 | 23 | 92 | 66.67 |
| chips | 57 | 10 | 40 | 101 | 10 | 13 | 2 | 40 | 52 | 8 | 25 | 100 | 60.00 |
| French | 40 | 9 | 36 | 82 | 16 | 9 | 0 | 64 | 36 | 0 | 25 | 100 | 66.67 |
| friends | 40 | 9 | 36 | 78 | 20 | 5 | 0 | 80 | 20 | 0 | 23 | 92 | 69.33 |
| tulips | 19 | 5 | 20 | 37 | 17 | 7 | 5 | 52 | 28 | 20 | 18 | 72 | 48.00 |
| two lips | 19 | 5 | 20 | 50 | 22 | 3 | 0 | 88 | 12 | 0 | 21 | 84 | 64.00 |
| the meat | 20 | 18 | 72 | 38 | 15 | 7 | 3 | 60 | 28 | 12 | 20 | 80 | 70.67 |
| them eat | 20 | 18 | 72 | 51 | 3 | 17 | 5 | 12 | 68 | 20 | 25 | 100 | 61.33 |
| pea stalks | 21 | 20 | 80 | 39 | 11 | 7 | 7 | 44 | 28 | 28 | 17/7 | 68/28 | 57.33 |
| peace talks | 21 | 20 | 80 | 52 | 13 | 6 | 6 | 52 | 24 | 24 | 16 | 64 | 65.33 |
| princess | 22 | 24 | 96 | 40 | 22 | 3 | 0 | 88 | 12 | 0 | 25 | 100 | 94.67 |
| prince S | 22 | 24 | 96 | 53 | 23 | 2 | 0 | 92 | 8 | 0 | 20 | 80 | 89.33 |
| way to | 23 | 9 | 36 | 41 | 21 | 22 | 2 | 84 | 8 | 28 | 21 | 84 | 68.00 |
| waiter | 23 | 9 | 36 | 54 | 4 | 21 | 0 | 16 | 84 | 0 | 15 | 60 | 37.33 |
| grey tie | 24 | 21 | 84 | 42 | 21 | 2 | 2 | 84 | 8 | 8 | 25/23 | 100/92 | 88.00 |
| great eye | 24 | 21 | 84 | 55 | 20 | 4 | 1 | 80 | 16 | 4 | 16/23 | 64/92 | 80.67 |
| at our house | 25 | 18 | 72 | 56 | 1 | 17 | 7 | 4 | 68 | 28 | 25 | 100 | 58.67 |
| a tower house | 25 | 18 | 72 | 43 | 19 | 0 | 6 | 76 | 0 | 24 | 21 | 84 | 77.33 |

| IT | D | | | I | | | | | | V | | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| nitrate | 26 | 9 | 36 | 57 | 8 | 8 | 9 | 32 | 32 | 36 | 20 | 80 | 49.33 |
| night-rate | 26 | 9 | 36 | 44 | 8 | 6 | 11 | 32 | 24 | 44 | 18 | 72 | 46.67 |
| our milk | 27 | 15 | 60 | 45 | 13 | 8 | 4 | 52 | 32 | 16 | 25 | 100 | 70.67 |
| sour milk | 27 | 15 | 60 | 58 | 14 | 8 | 3 | 56 | 32 | 12 | 12 | 48 | 54.67 |
| a name | 28 | 15 | 60 | 46 | 25 | 0 | 0 | 100 | 0 | 0 | 24 | 96 | 85.33 |
| an aim | 28 | 15 | 60 | 59 | 2 | 23 | 0 | 8 | 92 | 0 | 10 | 40 | 36.00 |
| free Danny | 29 | 17 | 68 | 47 | 18 | 6 | 1 | 72 | 24 | 4 | 22 | 88 | 76.00 |
| freed Annie | 29 | 17 | 68 | 60 | 10 | 13 | 2 | 40 | 52 | 8 | 22 | 88 | 65.33 |
| six ones | 30 | 17 | 68 | 48 | 19 | 0 | 6 | 76 | 0 | 24 | - | - | 73.00 |
| sick swans | 30 | 17 | 68 | 61 | 0 | 18 | 7 | 0 | 72 | 28 | 19/12 | 76/48 | 43.33 |
| newer dress | 31 | 12 | 48 | 49 | 17 | 8 | 0 | 68 | 32 | 0 | 25 | 100 | 72.00 |
| new address | 31 | 12 | 48 | 62 | 10 | 14 | 1 | 40 | 56 | 4 | 24 | 96 | 61.33 |
| 'white House | 32 | 7 | 28 | 63 | 6 | 18 | 1 | 24 | 72 | 4 | 23 | 92 | 48.00 |
| white 'house | 32 | 7 | 28 | 120 | 15 | 8 | 2 | 60 | 32 | 8 | 23 | 92 | 60.00 |
| 'flying aeroplanes | 33 | 19 | 76 | 64 | 20 | 0 | 5 | 80 | 0 | 20 | 23 | 92 | 82.67 |
| flying 'aeroplanes | 33 | 19 | 76 | 71 | 3 | 14 | 8 | 12 | 56 | 32 | 23 | 92 | 60.00 |
| 'dog-biscuits | 34 | 16 | 64 | 65 | 16 | 8 | 1 | 64 | 32 | 4 | 24/13 | 96/52 | 67.33 |
| dog 'biscuits | 34 | 16 | 64 | 72 | 15 | 8 | 2 | 60 | 32 | 8 | 24/13 | 96/52 | 66.00 |
| 'hunting dogs | 35 | 17 | 68 | 73 | 22 | 1 | 2 | 88 | 4 | 8 | 23/24 | 92/96 | 72.67 |
| hunting 'dogs | 35 | 17 | 68 | 66 | 14 | 10 | 1 | 56 | 40 | 4 | 23/24 | 92/96 | 72.67 |
| 'book-case | 36 | 17 | 68 | 67 | 6 | 16 | 3 | 24 | 64 | 12 | 9 | 36 | 42.67 |
| book 'case | 36 | 17 | 68 | 74 | 4 | 4 | 17 | 16 | 16 | 68 | 10 | 40 | 41.33 |
| 'visiting friends | 37 | 24 | 96 | 75 | 19 | 1 | 5 | 76 | 4 | 20 | 22/23 | 88/92 | 87.33 |
| visiting 'friends | 37 | 24 | 96 | 68 | 2 | 14 | 9 | 8 | 56 | 36 | 22/23 | 88/92 | 64.67 |

| IT | D | | | I | | | | | | V | | PT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DN | DFC | DPC | IN | IFC | IFO | IFT | IPC | IPO | IPT | VFC | VPC | |
| 'playing cards | 38 | 19 | 76 | 69 | 11 | 13 | 1 | 44 | 52 | 4 | 24/20 | 96/80 | 69.33 |
| playing 'cards | 38 | 19 | 76 | 76 | 19 | 3 | 3 | 76 | 12 | 12 | 24/20 | 96/80 | 80.00 |
| 'frying chickens | 39 | 18 | 72 | 70 | 6 | 7 | 12 | 24 | 28 | 48 | 15/16 | 60/64 | 52.67 |
| frying 'chickens | 39 | 18 | 72 | 77 | 13 | 6 | 6 | 52 | 24 | 24 | 15/16 | 60/64 | 52.67 |

Jyväskylä Cross-Language Studies (JyCS), earlier
Jyväskylä Contrastive Studies,
edited by Kari Sajavaara and Jaakko Lehtonen

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